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2020 NSC CHIEF MARKER'S REPORT

SUBJECT:	**TECHNICAL SCIENCES**
PAPER:	**1**
DURATION OF PAPER:	**3 hours**

SECTION 1: (General overview of Learner Performance in the question paper as a whole)

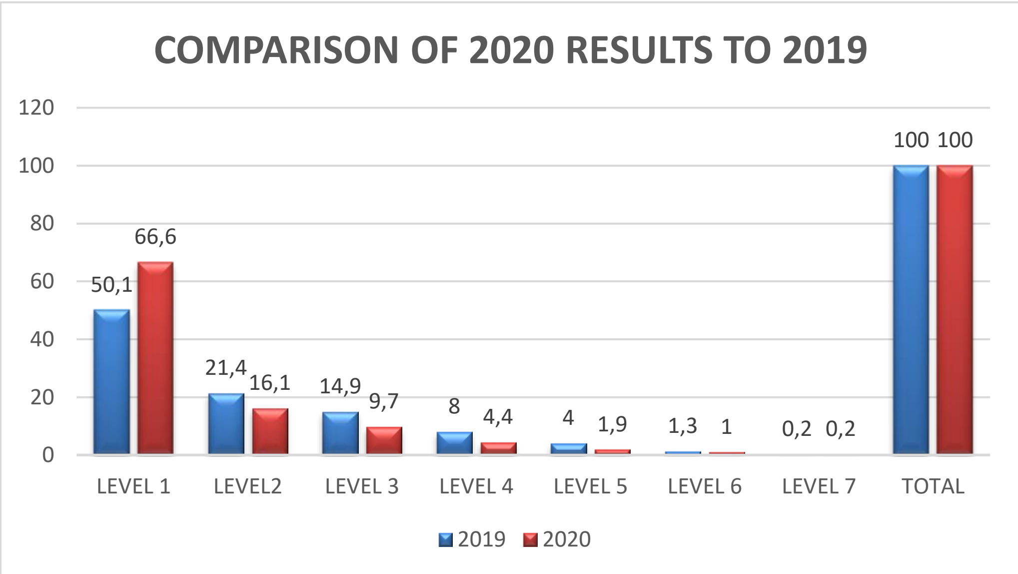
Performance of learners in 2020 indicates that the year was a very rough and tough year. academically and otherwise. The learner performance in the subject is a true reflection of how difficult it had been for both teachers and learners. Performance of Technical Sciences P 1 is at its lowest since the subject was introduced. Poor performance of 2020 shows a decline in results as compared to the previous years which is against what had been projected had there not been the COVID-19 pandemic. Learners performed very poorly in 2020 with a pass rate of 33,4 % which translates to a 15,7 % decline as compared to the 49,1 % pass rate of 2019. That is a very huge decline which went against the projected performance. This is worrying considering the fact that the paper was much easier than the previous years. The poor performance is attributed to many factors which will be discussed in the report.

From the table and graph below, it is clear that there is a great increase in the number of level 1s, which is supposed to decrease annually. 50,1% of 1669 learners performed at level 1 in 2019 and in 2020 there were 1336 learners who performed at level 1 which translates to 66,6% of the 2005 learners that wrote. This indicates that many learners were not adequately prepared for the final examinations. From level 2 to level 3 there is a noticeable decline in the percentage of learners who performed at those levels as compared to 2019, as indicated in the table and the graph below. The performance at level 7 is consistent at 0,2 % for both years.

The table below shows comparative analyses of 2019 and 2020:

	2019		2020	
LEVEL	**NUMBER**	**PERCENTAGE**	**NUMBER**	**PERCENTAGE**
1	836	50,1	1336	66,6
2	358	21,4	322	16,1
3	248	14,9	194	9,7
4	134	8,0	89	4,4
5	67	4,0	39	1,9
6	22	1,3	20	1,0
7	4	0,2	5	0,2
TOTAL	**1669**	**100**	**2005**	**100**

The graph below shows the number of learners (in %) per level:



A breakdown of question by question analysis will be discussed in section 2 below. Data used was collected from the 100 sampled scripts and discussions are also based on general observations during marking and moderation of learners' scripts.

SECTION 2: Comment on candidates' performance in individual questions

(It is expected that a comment will be provided for each question on a separate sheet).

QUESTION 1: All topics: {59 %}

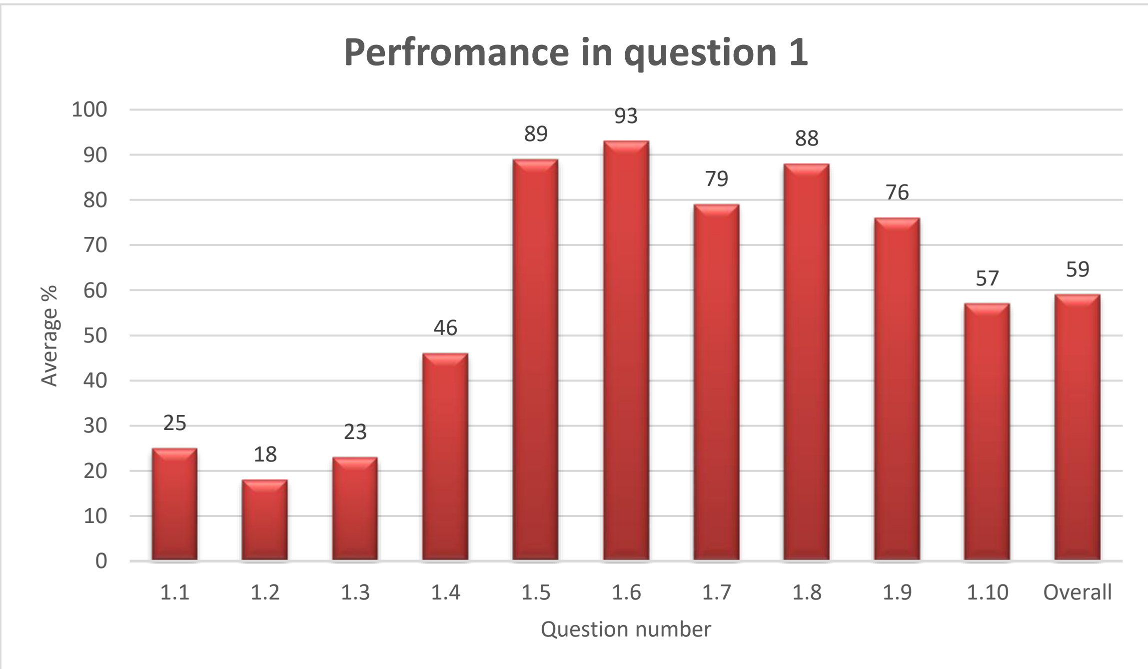
(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

This is a Multiple-choice Question in which learners were expected to perform between 60 % and 80 % on average. A performance at an average of 59 % is not pleasing. The question's performance was lowered by poor performance of learners on Mechanics related questions, i.e. questions 1.1 to 1.4.

The table below is showing a general performance of learners in question 1:

Question	Topic	Ave. %
1.1	Newtons' third law	25%
1.2	Types of forces	18%
1.3	Impulse and change in momentum	23%
1.4	Conservation of linear momentum	46%
1.5	Work	89%
1.6	Hydraulics	93%
1.7	Elasticity	79%
1.8	Power	88%
1.9	Electromagnetic Induction	76%
1.10	Faraday's law	57%

The following is a graphical representation of candidates' performance on question 1:



(b) Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.
The question's performance was lowered by performance in questions 1.1, 1.2, 1.3, and 1.4. These questions are all under Mechanics. Learners were unable to get these questions correctly. In questions 1.1 and 1.2 learners could not correctly identify forces acting on the objects. They also failed to identify forces that are relevant as per the questions asked. In 1.2. the least poorly performed subquestion at 18 %, a misconception was observed about the tension force. Learners understood tension as a force acting in the direction of the applied force. This caused learners to choose various incorrect options. In question 1.3 learners showed inability to properly analyse the graph. They could not realize that the gradient of the graph in the stem of the question is constant and it is equal to F_{net}. They could not identify the correct answer as option A which shows that F_{net} is constant as F_{net} is the gradient of a straight-line graph in the stem of the question. Another approach to question 1.3 learners should have used relationships between variables. Since in the stem of the question Δp and Δt were dependent and independent variables respectively, then F_{net} should be constant, and the only correct option is option A. In question 1.4 learners failed to show ability to apply the principle of conservation of linear momentum, which is only applicable if the system is isolated and the net external force acting on such a system is zero.

(c) Provide suggestions for improvement in relation to Teaching and Learning
A Multiple-Choice-Question (MCQ) demands high degree of content knowledge from the candidates. It demands a clear and effective strategy of getting the correct answer from the four possible answers and it spares no room for guess work. When preparing for examinations learners must also revise MCQ expansively employing a correct strategy to answer the questions. They may get correct answers by properly analysing the question and working out the correct answer before looking at the given four possible answers. Theirs will be to choose the option with the correct answer they have worked out. This may, in some cases, be preceded by applying the elimination method. This method involves logical reasoning in eliminating the incorrect options until one is left with the correct option, and if there is still uncertainty, learners work out the correct answer. Teachers must teach basic concepts well. Certain questions required a thorough understanding of relationships between variables and therefore they need to be well taught.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.

Although learners scored better marks in most of the subquestions, there are still indications of guess work employed by candidates. Learners are unable to properly analyse questions. This makes them not to understand what is required in the question. Educators and subject advisors are thence advised to regularly assess learners on answering of MCQs. They may introduce short topic tests that are MCQs in nature. In answering these questions, learners may also be caused to give reasons for eliminating other options. This will equip learners with skills to answer MCQs. The most common misconception is between magnetic flux and magnetic field, learners think they are the same, therefore thorough teaching must be done.

QUESTION 2: Newton's first law of motion and frictional force: {43 %}

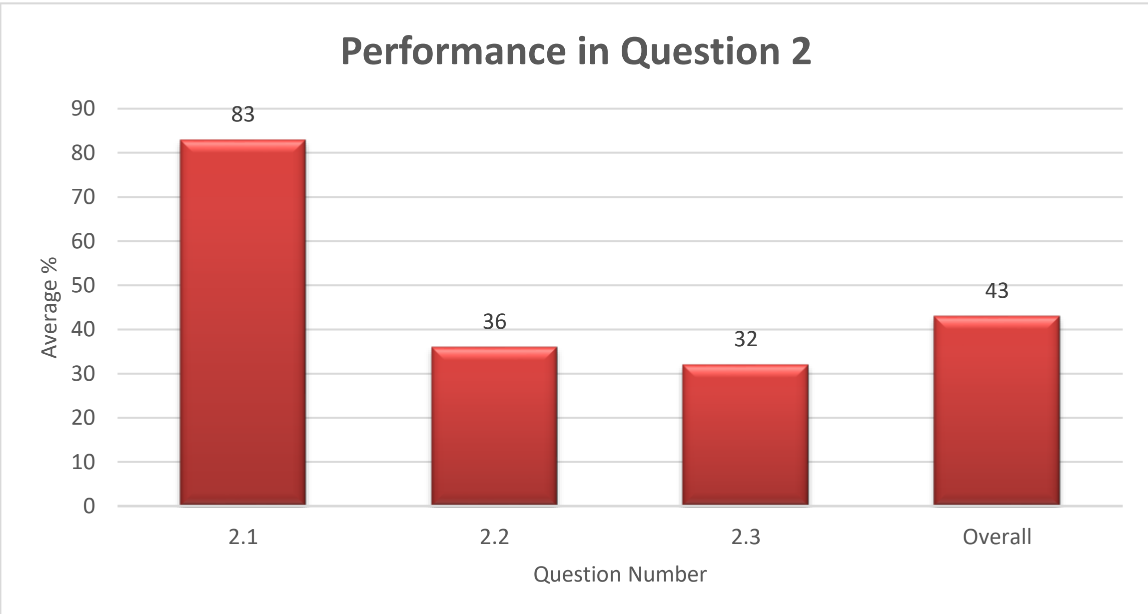
(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

This question was poorly answered by learners with average percentage of only 43 %. Poor performance in this question may be attributed to inadequate preparations by learners. Concepts asked were simple and straight forward.

The table below contains performance of learners per sub-question

Question	Topic	Ave. %
2.1	Newton's first law	83%
2.2	Frictional force and resultant force	36%
2.3	Inertia and its application	32%

The graph below shows performance of candidates in the sub-questions of question 2:



(b) Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

Although learners did well in question 2.1 (stating Newton's first law of motion) some of them still lost marks by omitting important phrases in the statement and others by stating it incorrectly. There are many learners who got only 1 mark out of the 2 marks in 2.1as they omitted key concepts when stating the law.

Question 2 was poorly answered because learners failed to answer question 2.2 and question 2.3 correctly. In question 2.2 candidates were unable to correctly use addition of vectors method in order to determine kinetic friction (f_k). They could not identify forces that have a direct influence in the motion of an object, i.e. f_k and horizontal component of the applied force (F_H or F_X). They were missing the fact that if an object is travelling at a constant velocity, then F_{net} = 0 N. Most of them used gravitational acceleration instead of zero acceleration as velocity was given to be constant. It is a misconception that lead learners to make f_k negative in the formular step. For example, some learners wrote the formular as $FCos40^0 – f_k = 0$ instead of $FCos40^0 + f_k = 0$. Those who did so ended up obtaining a positive value for f_k which incorrectly implied that f_k and F_x were both to the same direction. If everything is done correctly it should be the value of f_k that comes out negative, such that f_k will have both magnitude and direction (indicated by a negative sign).

In question 2.3 learners were unable to correctly define Inertia as it was asked in 2.3.1 with an average percentage of only 49 %. Some learners define inertia as the mass of an object and the majority would omit key phrases like "***resisting a change***".

Question 2.3.2 with 21% average was the worst performed in 2.3. Candidates were unable to logically reason out the impact of a change in mass on the inertia of an object. They did not know the relationship between mass and inertia. Those who made the correct choice in the first part of the question could not logically explain their choice.

(c) Provide suggestions for improvement in relation to Teaching and Learning

In teaching Newton's laws, educators must emphasise key phrases in the statements, explain using sketch diagrams the meaning and importance of each phrase and apply the law in various contexts. Teachers must teach learners to use scientific reasoning in applying the laws and science principles to explain various phenomena. Calculations based on the laws must be taught and learners must be exposed to various contexts. Learners must always be caused to use different methods of calculating the resultant. Teachers must teach learners to only put a negative sign next to the magnitude of a vector during the substitution step when using Addition of Vectors method.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.
It was observed that learners cannot use scientific reasoning to explain their choices. This was coupled with the inability of learners to identify relationships between variables. Educators must always explain relationships between variables and represent such relationships graphically. This would assist learners to understand graphs and be able to interpret them correctly. The addition of Vectors Method must be taught well in Grade 10. Emphasis must be put identifying correct directions of vectors and indicate those directions using negative and positive signs. Definitions of key concepts must be given special attention and learners must be caused to attach meanings to various definitions. Learners must frequently be assessed on the definition of concepts using CAPS and Examinations Guideline as sources of information.

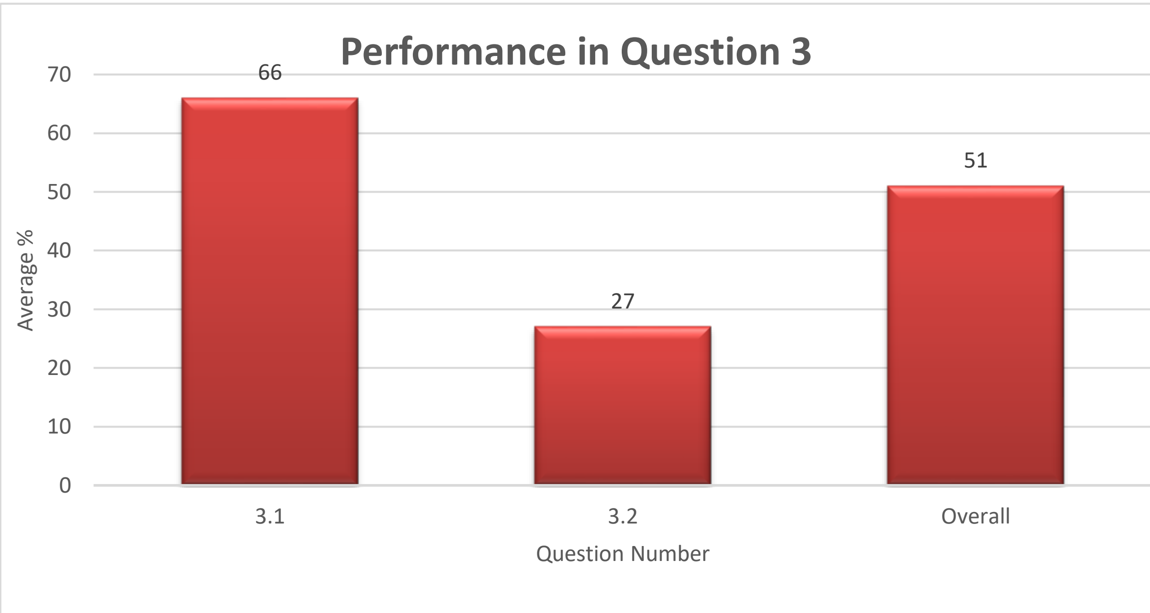
QUESTION 3: Tension, normal force & coefficient of kinetic friction: {51 %}

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Candidates performed fairly in this question with an average percentage of 51 %. Candidates did well in question 3.1 with an average percentage of 66 %. Candidates lost marks in question 3.2 as it was the worst performed question with an average percentage of 27 %. The table below contain average percentages per sub-question:

Question	Topic	Ave. %
3.1	Definition and identification of tension	66%
3.2	Coefficient of kinetic friction	27%

The graph below represents performance of candidates in question 3:



(b) Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.
The question was poorly answered as learners lost marks in question 3.1.1 and they performed at an average percentage of 38 %. Learners were required to define and identify tension. They poorly performed as they failed to define tension correctly. Most of them defined it as a string or a rope, not correctly as a force in the string or rope. As they were required to identify an example of tension, they could not do so and most of them did not answer that part of the question. Learners could not correctly state the impact of a force pulling at an angle on the kinetic friction experienced by an object, as required in question 3.1.2. In this question learners performed at an average percentage of 56 %. They did not know that the vertical component of such a force tends to lift an object up from the surface and thus reducing the amount of frictional force experienced by the object. Learners did fairly well in 3.1.3 with an average percentage of 87 %. Some candidates lost marks in this question as they failed to draw and label a free-body diagram. Most of those who lost marks did not label/ did not correctly label forces, incorrectly resolved the tension into its components and some forces were given incorrect directions. In question 3.2 learners performed poorly with an average percentage of 32 %. Candidates failed to correctly identify all forces that influence the motion of an object. Some could not calculate the horizontal component of the force applied by Zane. Some learners calculated F_{net} although it was given in the question. Most learners failed to calculate the normal force correctly as they excluded the vertical component of Zane's force in their calculations. Most learners did not know even the basic formular needed in the question that of $f_k = \mu_k N$.

(c) Provide suggestions for improvement in relation to Teaching and Learning
Learners must be taught types of forces such that they are able to identify and define them. Educators must emphasise that when drawing free-body diagrams forces must: • Be represented by arrows • Start from a dot and move away from the dot to their respective directions. • All touch the dot • Be labelled using ***correct*** labels. • Resolve a force acting at an angle to its perpendicular components as this would assist when calculating any force as required by the question. Learners must be exposed to various contexts where they will be required to perform calculations based on free-body diagrams. Learners must be exposed to various contexts where Newton's laws are applied in calculations. Teachers must do more exercises on calculations of a normal force using various contexts.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.
Different kinds of forces must be thoroughly taught in grade 10 and be revised well in grade12. These include definitions of forces, drawing and labelling force and free-body diagrams. Calculations involving friction must be taught well in grade 11. Grade 10 and 11 exercises must be included in activities given to grade 12 learners in order to give more revision on the work covered in the previous grades. Teachers must encourage learners to draw free-body diagrams whenever they are dealing with forces, even if that is not demanded by the question. This will assist them in understanding what is happening in the question and be able to answer questions correctly. It is a misconception to tell learners that a normal force (F_N) is always equal to the weight of an object.

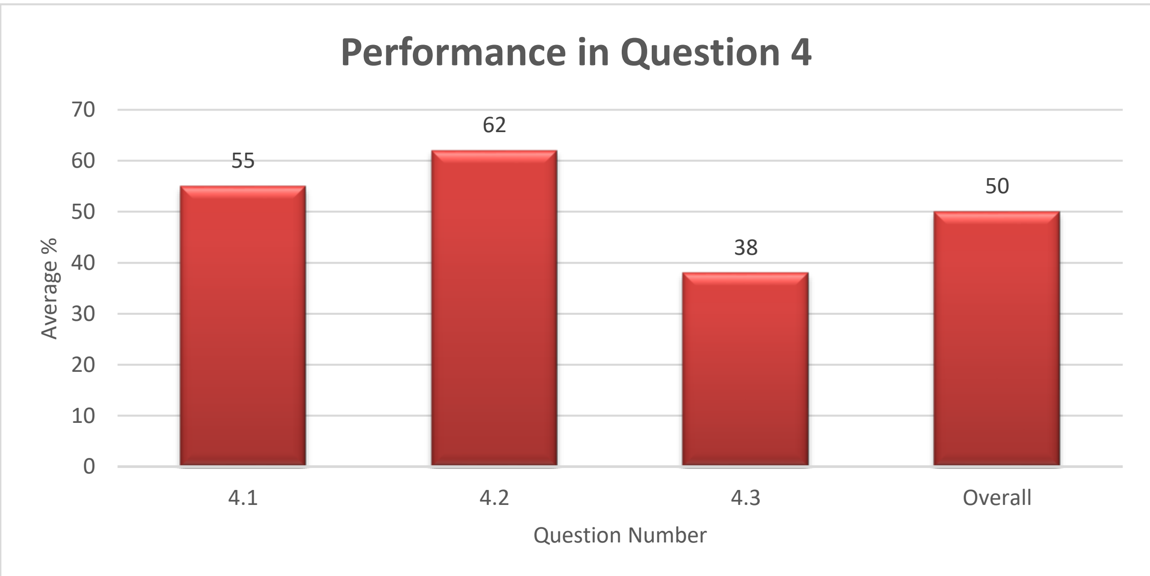
QUESTION 4: Momentum, Impulse & types of collisions: {50 %}

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Candidates performed fairly with an average percentage of 50 %. Candidates had challenges with scoring high marks in question 4.3 in which they performed at 38 %. The table below shows performance per sub-question:

Question	Topic	Ave. %
4.1	Momentum	55%
4.2	Conservation of linear momentum and types of collisions	62%
4.3	Impulse and its applications	38%

Performance in this question is also represented graphically in the graph below:



(b) Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.
Learners did perform very well when they were required to define momentum in question 4.1.1 as they got 97 %. Definition is simple and straight forward, but some learners continued to lose marks as they would omit the key phrase, ***"product of"*** in the definition. Question 4.1.2 was a simple conversion calculation and learners performed poorly at 25 %. They failed to convert 120 $km.h^{-1}$ to $m.s^{-1}$. Most of them failed to indicate correct direction for the velocity and lost a mark. In question 4.1.3 (47 %) learners could not correctly calculate initial momentum of the car. They would either use the truck's velocity/mass or not indicate direction of the momentum. Some learners calculated change in momentum (Δp) and they lost all the marks. Although candidates did well in 4.2.1 (89 %) they continued to omit key phrases/words, like ***"total/ linear/isolated system"*** when required to state the Principle of conservation of linear momentum. In question 4.2.2 learners performed at 51 %. Most learners failed to calculate total kinetic energy before collision and total kinetic energy after collision and compare the two to conclude whether the collision was inelastic or elastic. They instead calculated momenta, which was totally incorrect, and those learners lost all the marks. Some learners did not separately calculate $\sum Ek_{before}$ and $\sum Ek_{after}$, most of them put it as if they are equal from the beginning. Learners also did not know that they must use the velocity calculated in 4.1.2 in the substitution. Question 4.3 was the worst performed question in question 4 with an average percentage of 38 %. Learners showed inability to identify relationship between variables in 4.3.1 (40 %), failed to use scientific reasoning to explain a given situation in 4.3.3 (32 %) as instructed in the question. Although the question demanded that candidates use impulse in the explanation but majority of them used change in momentum, and they lost a mark. Candidates did not display knowledge of the relationship between F_{net} and contact time. In question 4.3.4 (37 %) majority of learners lost marks for failing to show understanding of the fact that F_{net} and initial velocity are vectors, and they were having opposite directions. For that candidates lost 2 marks in the calculation as they ended up with a negative value for time.

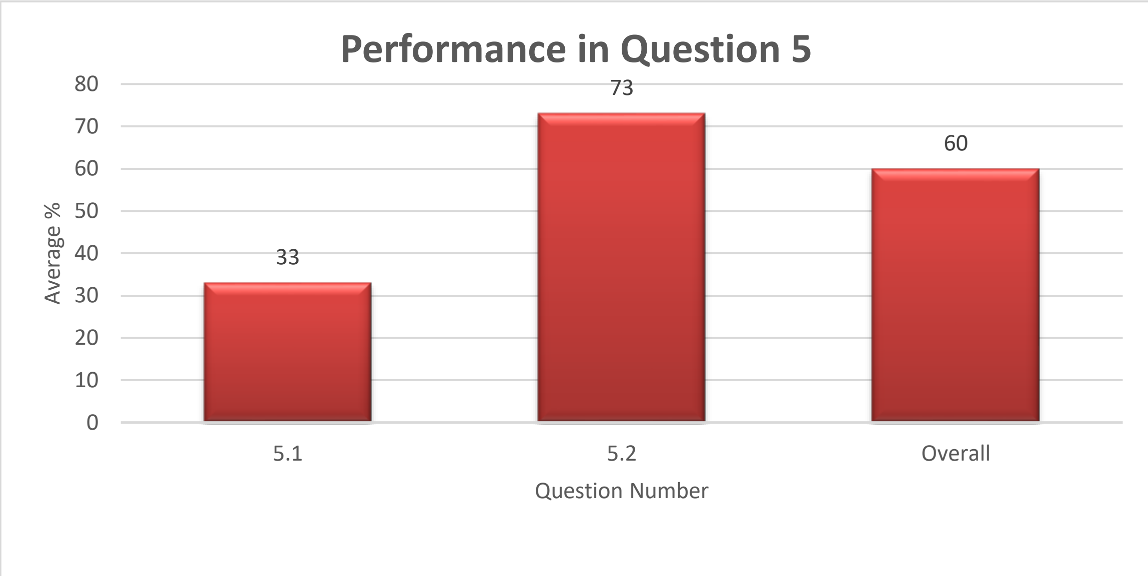
(c) Provide suggestions for improvement in relation to Teaching and Learning
Conversion of units must be thoroughly taught in grade10. Teachers must train learners to always indicate the direction when working with vector quantities in all calculations. Teachers must teach leaners to begin by choosing which direction is positive in order to see which velocity must be positive or negative. More examples and activities must be given on the concept of calculating impulse, net force and contact time. Learners must be taught to calculate total kinetic energy before collision separately from the total kinetic energy after the collision, compare the answers and write a conclusion. This is the only basis to conclude whether a collision is elastic or inelastic. To differentiate between elastic and inelastic collision, emphasis must be put that in either collisions the total momentum before collision and the total momentum after collision is conserved, but what can change is only the sum of the kinetic energies. Teachers must thoroughly explain the relationship between net force, contact time and impulse using real life applications of impulse.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.
The topic of momentum and impulse has easy-to-get marks. Teachers must teach the topic thoroughly explaining all the important aspects and they must make time to revise the topic. Learners must be exposed to various context of calculations and they must always be reminded about vector nature of velocity and force when dealing with the topic. Teachers must emphasise to learners that momentum is a vector quantity; its direction must always be shown in calculations. Learners must be taught to identify dependent, independent and controlled variables in any give situation.

QUESTION 5: Work and Energy: {60 %}
(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?
Learners performed well in this question with an average percentage of 60 %. They were boosted by question 5.2 (73 %) which was mostly based on calculations. Learners did not do well in question 5.1 (33 %) which involved two simple calculations. The table below shows performance of learners in the question:

Question	Topic	Ave. %
5.1	Work	33%
5.2	Mechanical energy calculations	73%

Graphical representation of learners' performance is shown below:



It was question 5.1.2 that dropped the average performance in the whole question.

(b) Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

Learners failed to score high marks in the simple calculations asked in question 5.1. In question 5.1.1 (57 %) learners lost marks for using incorrect formula for calculating work done (W = FΔxCosθ). They either used wrong formula or incomplete formula in the calculation. The formula is given in the data sheet, but learners failed to copy and use it. Most of them omitted Cosθ in the formula. They did not use the angle of 0° as required. Some used other incorrect angles. Question 5 was grossly negatively affected by question 5.1.2 (15 %). Learners could not use the correct formula to calculate $W_{net} = F_{net}\Delta x\cos\theta$. They used incomplete formula, failed to correctly calculate F_{net} and failed to correctly calculate work done by gravity. Almost all candidates could not get 100 % in this sub-question, hence an average of 15 %.

It was in question 5.2 (73 %) where learners got marks. The majority of them did well when required to state the Principle of Conservation of Mechanical Energy in question 5.2.1 (81 %). In doing so, some learners still omitted key words such as ***"Total, Gravitational, isolated system, remains constant"***. That resulted in the loss of marks. In question 5.2.2 (85 %) some learners lost marks as they substituted a non-zero velocity at point A. In question 5.2.3 (67 %) learners lost marks for failing to correctly apply the principle of conservation of mechanical energy and for substituting non-zero value for the height. Question 5.2.4 (65 %) learners could not correctly calculate kinetic energy at point C. This resulted in them calculating the velocity incorrectly. Some did not use the height of 3 m given in the question.

(c) **Provide suggestions for improvement in relation to Teaching and Learning.**
Teaching of basic concepts in this topic must be thoroughly done. Teachers must train learners to use data sheets throughout the year. Teachers must teach learners about the angle in the formular. It must be emphasised that θ is the angle between the force doing work and the direction of motion. Calculation of total work done must be taught thoroughly. Learners must be able to use various approaches, i.e. either to calculate F_{net} first, or to calculate work done by individual forces separately. Learners must be trained to always draw a free-body diagram when answering this type of a question. This will assist them in identifying all the forces that do work on the object. Teachers must also give learners exercises of vertical motion. Learners must be taught the use of $M_E = E_k + E_p$ at various levels of the fall/vertical motion to calculate any of the variables at various points.

(d) **Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.**
The use of complete formulae for work must be emphasised to learners. When teaching this topic, teachers must refrain from using incomplete formulae as this may mislead learners. Teachers must put emphasis on the use of correct formulae and substitutions when giving activities to learners and exposed to examples of real application of work done on an object. Learners must be shown how they could lose marks should they omit certain information on calculations.

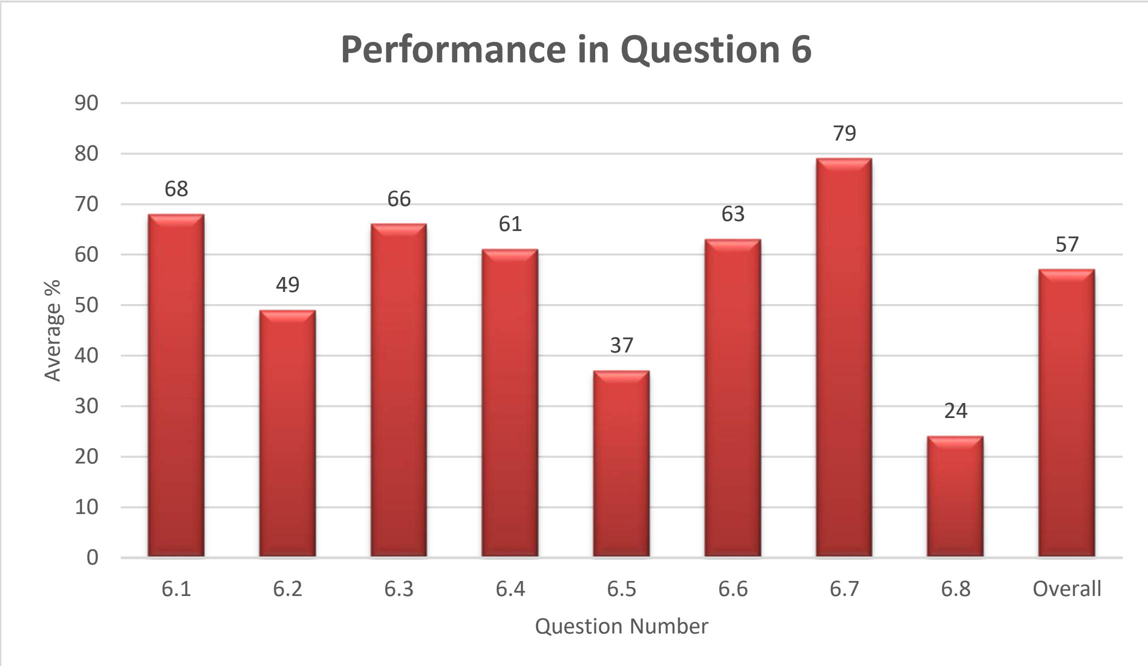
QUESTION 6: Elasticity, Viscosity & Hydraulics:- {57 %}

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Candidates performed well in this question with an average percentage of 57 %. Question 6.7 (79 &), which was a calculation, boosted the average of the question, while questions 6.5 (37 %), where learners were required to give examples of perfectly plastic bodies, and 6.8 (24 %), definition of ***thrust***, lowered the question's average percentage. The table below gives performance of learners:

Question	Topic	Ave. %
6.1	Stress and Strain	68%
6.2	Stress and Strain	49%
6.3	Viscosity	66%
6.4	Perfectly plastic body	61%
6.5	Perfectly plastic body	37%
6.6	Pascal's law	63%
6.7	Hydraulics	79%
6.8	Hydraulics	24%

Below is the graphical representation of how candidates performed in the question:



There were many subquestions in this question where learners could have scored marks.

(b) **Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.**
In questions 6.1.1(65 %) and 6.1.2 (71 %) learners lost marks as they omitted key words such as ***"internal/restoring/per"*** when defining stress and key words such as ***"ratio/change"*** when defining strain. Questions 6.2.1 (40 %), calculation of strain when given modulus of elasticity, and 6.2.2 (56 %), calculation of force exerted on the bar when given diameter, proved to be challenging to most learners. Their challenges ranged from choice of correct formular, conversion of units (MPa and GPa to Pa), calculation of area when given diameter to not writing the final answer with correct SI units. In question 6.3 (66 %) some learners could not correctly give the relationship between temperature and viscosity. On defining perfectly plastic body in question 6.4 (61 %), learners omitted key phrases/words such as ***"does not show a tendency/to regain/ deforming"*** because of that they lost marks. A very simple question 6.5 (37 %) was the worst performed. Learners were required to only give examples of perfectly plastic bodies, and they failed to give correct examples. In question 6.6 (63 %), stating Pascal's law, learners lost marks for omitting key phrases like ***"in a continuous liquid at equilibrium/transmitted equally"***. Question 6.7 was performed well at 79 %, but some learners lost marks because of incorrect substitution and sometimes because of use of incorrect formular. Question 6.8 was the worst performed question in the whole question 6with only 24 % average percentage. Learners just did not know definition of ***thrust***.

(c) **Provide suggestions for improvement in relation to Teaching and Learning**
All the definitions must be taught in the context of CAPS and Examination Guidelines. Definitions of concepts must form part of daily activities given to learners. Teachers must not only focus on long questions and calculations when giving activities. Teachers must thoroughly revise calculating the area for different shapes. Teachers must give different questions of calculating strain that also involve modulus of elasticity and stress. Learners must be given skills for selecting appropriate formular for calculations which involves identification of variables given in the question.

(d)	**Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.**

Dismal failure by learners to define "***thrust"*** is an indication that it was never taught to most of the learners. That is an indication that teaching is driven by previous years' question papers in many schools. What had not been assessed in the previous years, is not taught. There were indications that grade 10 and grade 11 work was not thoroughly taught. Learners were challenged by conversion of units which is grade 10 work.

Learners seem to forget certain concepts like calculating area which is covered in grade 8 mathematics. Teachers must note that thorough revision of previous grades' work is required for certain topics. When starting a new topic, teachers must identify the concepts covered in previous grades, revise and assess them, in that way they will be able to close those contents gaps.

QUESTION 7: Semiconductors, Electrostatics, Electricity: {41 %}

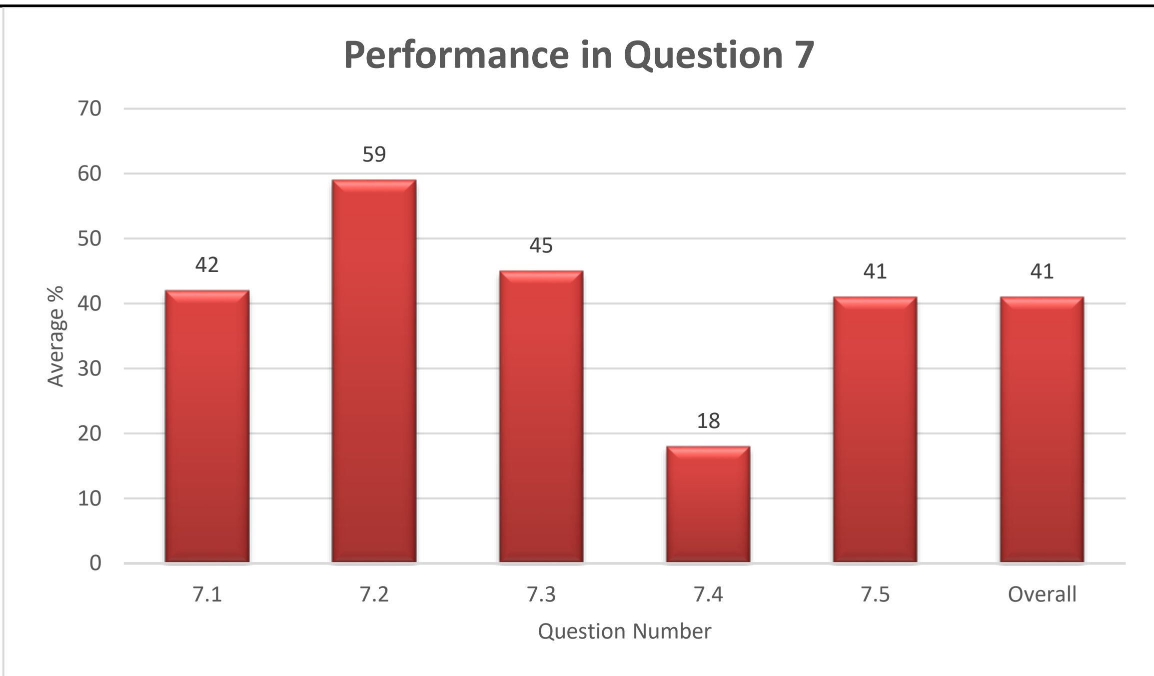
(a)	**General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?**

This question was easily set for leaners to score marks. It's unfortunate that the question was poorly answered at 41 % average percentage. Most sub-questions in this question were performed below 50 %, with question 7.4 being the worst performed question at only 18 % average percentage.

Performance of candidates is tabulated below:

Question	Topic	Ave. %
7.1	Semiconductors	42%
7.2	p-n junction diode	59%
7.3	Capacitors	45%
7.4	Capacitors	18%
7.5	Practical unit of power and cost of electricity	41%

Below is a graphical representation of learners' performance:



From the graph it can be noted that questions 7.1, 7.3 and 7.5 all contributed to the low average percentage in the question.

(b) Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.

In question 7.1.1 (64 %) learners failed to correctly name the types of materials indicated in the given diagram. Simple as it was, they just could not figure out that what was required was p-type and n-type materials, respectively. In question 7.1.2 (24 %) learners failed to correctly draw a symbol of p-n junction diode which they were not even required to label. Most of them drew a circuit, some a cell and others did not even attempt the question. Number of valence electrons in an intrinsic semiconductor was required in question 7.1.3 (37 %), and learners failed to provide the correct number. They showed no understanding of the term ***"valence electrons"***. Defining a capacitor in 7.2 (59 %) proved to be a challenge to many learners. Many learners lost marks as they defined it as a device that stores ***electricity*** instead of ***charge***. In questions 7.3 (45 %) and 7.4 (18 %) learners showed a huge content gap. They did not know the relationship between capacitance and the charge in question 7.3 and most would say they are inversely proportional. Learners did not know factors affecting capacitance in question 7.4. Some learners just stated the factors without necessarily answering the question. For example, a learner would write ***surface area***, instead of writing ***decrease surface area of the plates*** as the question required them to do. That was the reason why question 7.4 became the worst performed sub-question. In question 7.5 (41 %) learners lost marks for not calculating cost of electricity. They calculated only power and did not convert it to kW. Most learner failed to correctly calculate the energy used in kWh. Most of them did not reach the step for calculating cost of electricity, so their calculation was incomplete.

(c) Provide suggestions for improvement in relation to Teaching and Learning
Teachers must use a periodic table when teaching semiconductors and the concept of valence electrons must be properly taught in Grade 10. A correct definition of a capacitor and factors affecting capacitance must be taught as prescribed in both CAPS and Examination Guidelines. Teachers must explain the effect of factors affecting capacitance on capacitance. Learners must know how each factor affects capacitance. Learners must be assessed regularly on capacitors and be exposed to various questions. More activities must be given in electricity with more emphasis put on calculating the cost of electricity.

(d) Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.
Teaching of basic concepts must be retrospective to previous grades' work. Components of an electric circuit and their symbols must be taught accesses in Grade 10 then revised in Grade 12.

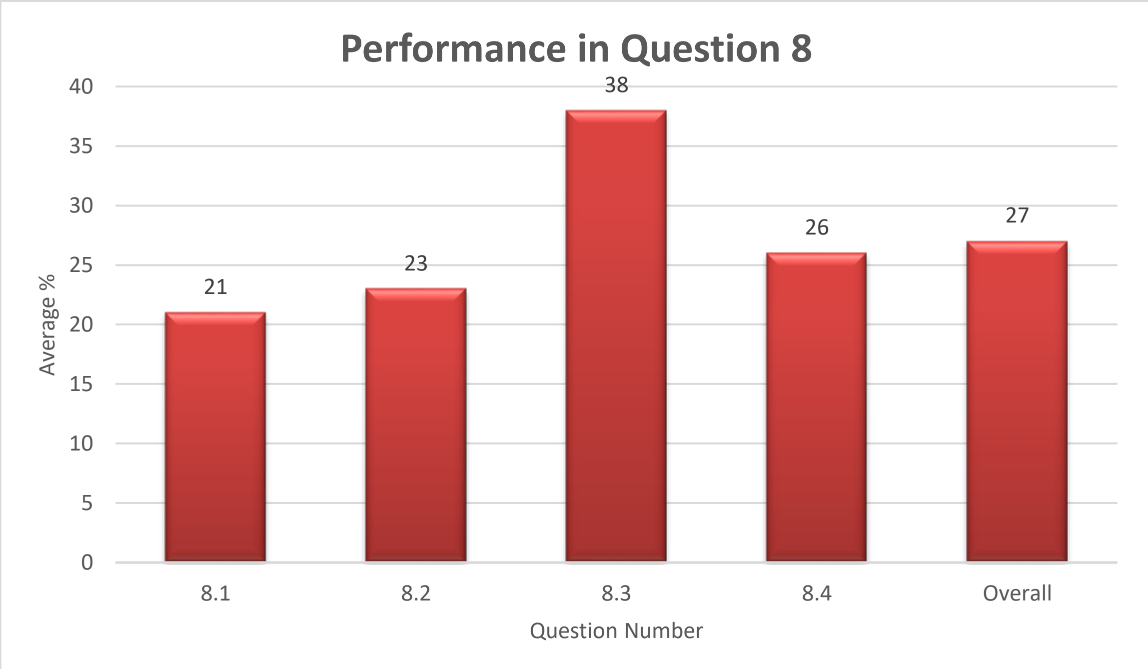
QUESTION 8: Electromagnetism & Lenz's Law:- {27 %}

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Question 8 was the worst performed question in the whole question paper, with only 27 % average percentage. In all four subquestions, not even a single sub-question was performed above 40 %. The table below shows performance of candidates per sub-question:

Question	Topic	Ave. %
8.1	Electromagnetic Induction	21%
8.2	Electromagnetic Induction	23%
8.3	Lenz's law	38%
8.4	Applications of Lenz's law	26%

Graphical representation of learners' performance is represented below:



Learners failed to display knowledge of the content as there were no calculations in the question. Many learners scored a zero in this question.

(b) Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.
Learners could not define electromagnetic induction in question 8.1. Learners confused electromagnetic induction with Faraday's law, hence the question had a very low average of 21%. It was the first time that this definition was assessed. One is tempted to believe that teachers never taught it thoroughly. Learners struggled to give factors influencing the induced emf in question 8.2 and those who attempted to give the factors could not get the maximum 2 marks. When mentioning the speed of magnet, learners forgot to mention the coil and also to mention the relative motion between the magnet and the coil. In question 8.3 learners lost marks as they omitted key words/phrases such as ***"direction of/induced emf/effect that produces"***. Those learners who struggled with stating Lenz's law also struggled with its applications in question 8.4. Most learners could not get the 3 marks and majority of those who attempted the question got only a mark.

(c) **Provide suggestions for improvement in relation to Teaching and Learning**
Teachers must thoroughly teach the basics of electromagnetic induction for learners to be able to define it. Factors affecting the induced emf and applications of Lenz's law must be taught well as prescribed in the CAPS document and Examination Guidelines. Learners must be assessed regularly to measure the extent at which learning had taken place.

(d) **Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.**
The performance in the question indicates that the topic was not well taught. Teachers must give full attention to the topic as learners usually get fair marks in the question. Teachers must teach all the prescribed content, not only the content that had been assessed in the previous years. Previous years' question papers must not be the determinants of what must be taught. Teachers must use video simulations to explain the electromagnetism.

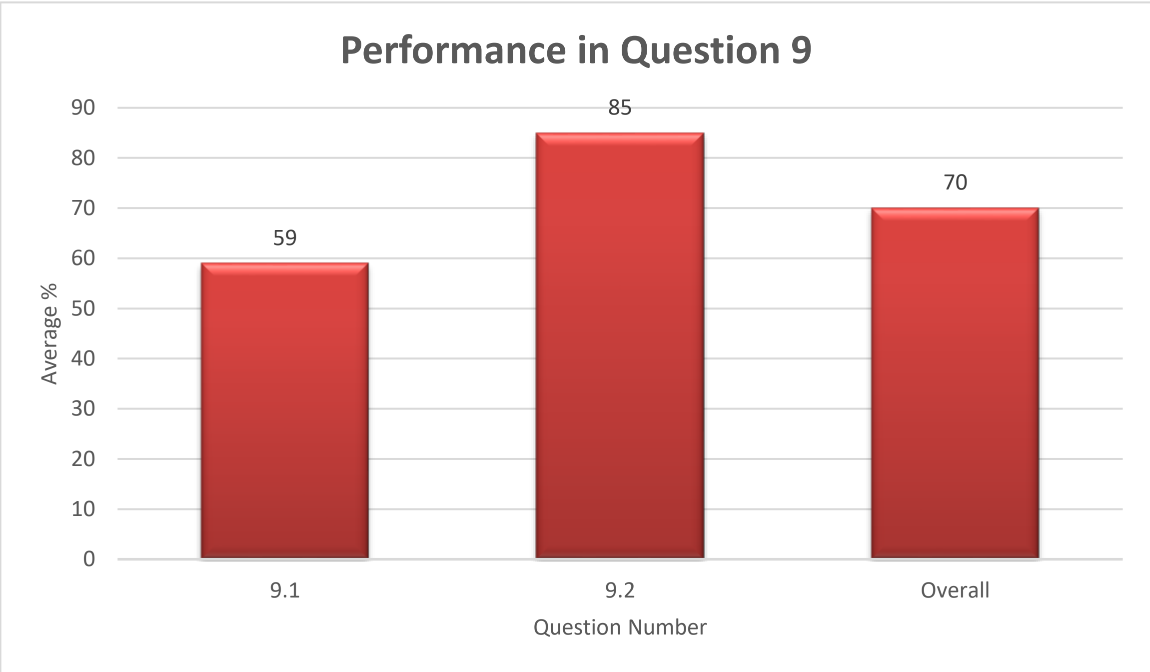
QUESTION 9: Motors, Generators & Transformers: {70 %}

(a) General comment on the performance of learners in the specific question. Was the question well answered or poorly answered?

Question 9 was well answered by learners with an average percentage of 70 %. Learners did very well in question 9.2 which was based on calculations involving transformers. In question 9.1 candidates did not do so well as they were given a diagram and were required to identify and label it. The table below shows performance of learners in the question:

Question	Topic	Ave. %
9.1	Electric motors	59%
9.2	Transformers	85%

The graph below shows performance of candidates per subquestion.



(b) **Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions.**
In question 9.1.1 (59 %) learners were expected to label parts indicated on the diagram. Those who lost marks could not correctly label the parts. This is an indication of substandard teaching and learning as learners were unable to identify the parts of an electric motor. In question 9.1.2 (59 %) learners failed to identify the type of motor from the diagram given in the question. In question 9.2 (85 %) some learners lost marks because of incorrect substitution. There are some who used a wrong formula. Some learners were losing a mark for the final answer as they had either not correctly rounded off or omitted the SI unit.

(c) **Provide suggestions for improvement in relation to Teaching and Learning**
Teachers must thoroughly teach learners on rounding off numbers as it is covered in the conversion of units in grade 10. They must train learners to always write correct SI units in classwork activities. They must also teach them how to derive an SI unit from a formula.

(d) **Describe any other specific observations relating to responses of learners and comments that are useful to teachers, subject advisors, teacher development etc.**
Teachers must refer to CAPS documents when teaching lower grades in order not to miss important concepts that can assist learners in grade12. In teaching electrical machines, teachers must not only teach learners to state differences between the machines, but they must also use clearly labelled diagrams to identify the features of each machine. Learners must be taught distinguishing features between motors and generators and between AC and DC machines.

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/
NATIONAL SENIOR CERTIFICATE

GRADE 12

TECHNICAL SCIENCES P1

NOVEMBER 2020

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

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

2. This question paper consists of NINE 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. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your FINAL numerical answers to a minimum of TWO decimal places.

11. Give brief motivations, discussions, etc. where required.

12 Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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 An object of mass **m** rests on a flat table. The Earth pulls this object with force **mg**, which is known as the action force. Which ONE of the following statements gives the best description of the reaction force?

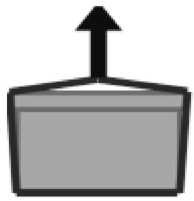
A The table is pushing the object up with force **mg**.

B The object is pushing the table down with force **mg**.

C The table is pushing the floor down with force **mg**.

D The object is pulling the Earth upward with force **mg**. (2)

1.2 A man lifts a 60 kg load with a rope at a constant velocity. What is the tension (force) in the rope? Ignore air friction.



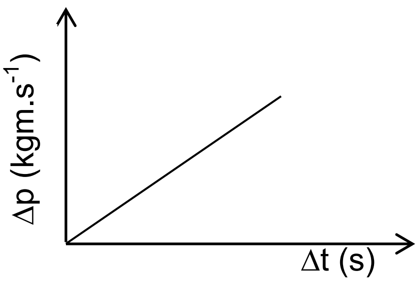
A 568 N, downwards

B 578 N, upwards

C 588 N, upwards

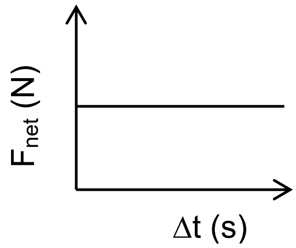
D 588 N, downwards (2)

1.3 The graph below represents the relationship between a change in momentum (Δp) of an object and change in time (Δt).

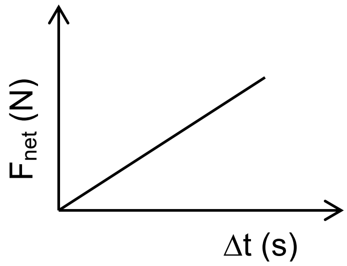


Which ONE of the following graphs represents a corresponding F_{net} versus time graph?

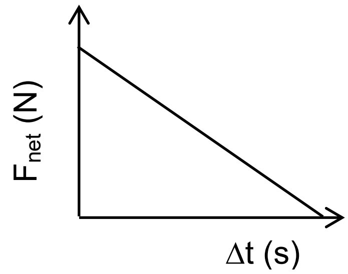
A



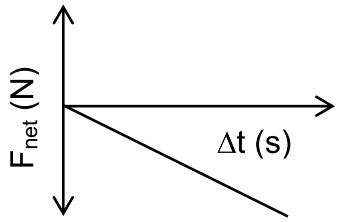
B



C

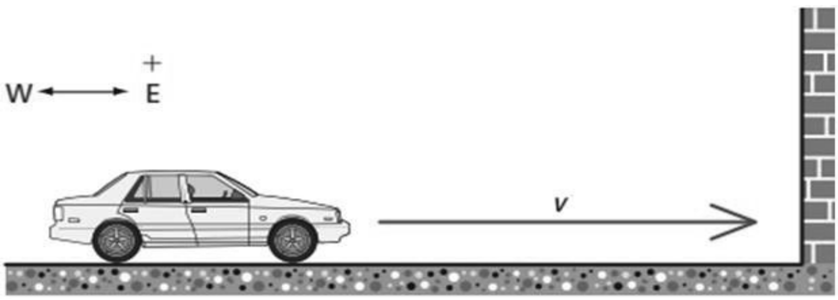


D



(2)

1.4 John and Thabo watched a car approaching a wall. The car hit the wall while travelling at velocity **v**. After a long argument about conservation of the car's momentum, they both agreed that total linear momentum will only be conserved if the net …



A force acting on the system is zero.

B external force acting on the system is zero.

C force acting on the system is greater than zero.

D external force acting on the system is greater than zero. (2)

1.5 Which ONE of the following statements on work is TRUE? Work is done when …

A the force is at 90° with the direction of displacement.

B the displacement is in the direction of the force.

C there is no resultant force and the displacement is zero.

D the displacement is zero and the applied force is greater than zero. (2)

1.6 The standard unit of pressure is ...

A pascal.

B newton.

C metres.

D kilograms. (2)

1.7 What is understood by the term *Young's modulus of elasticity*?

A The force required to produce a unit area in a tensile test.

B The ratio between stress and strain in a metal, provided that the limit of elasticity is not exceeded.

C A measurement of the extension or contraction of material due to the load experienced.

D The extent of the deformation because of the application of an external force. (2)

1.8 Electric power is measured in ...

A amperes.

B watts.

C volts.

D ohms. (2)

1.9 Magnetic flux can be defined as the number of magnetic field lines produced by a magnet … to a given surface.

A perpendicular

B horizontally

C diagonally

D parallel (2)

1.10 Faraday's law implies that when the rate of change of the magnetic flux increases, the induced emf will …

A stay the same.

B decrease.

C increase.

D be zero. (2)
[20]

QUESTION 2 (Start on a new page.)

The picture below shows a young boy on a sled ride with the assistance of his older brother. As the older brother applied a force of 80 N with his foot, at an angle of 40° to the horizontal, the sled and the boy moved at a constant velocity of 9 $m.s^{-1}$. The boy and the sled had a combined mass of 25 kg.

2.1 State Newton's First Law of Motion in words. (2)

2.2 What is the magnitude of the frictional force experienced by sled? (3)

2.3 The combined mass of the boy and the sled is now increased, while the force applied by the brother remains constant.

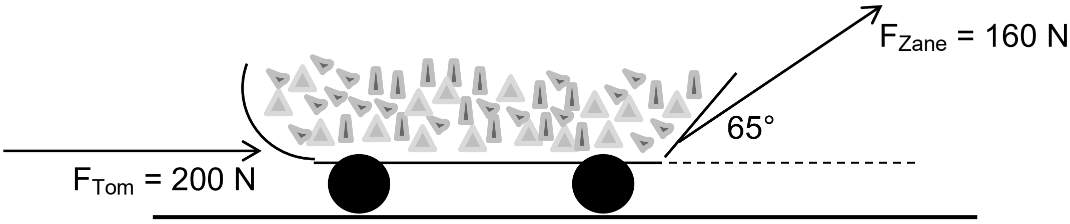
2.3.1 Define *inertia*. (2)

2.3.2 How will the inertia experienced by the brother be affected? Write only INCREASE, DECREASE or REMAIN CONSTANT. Explain your answer. (3)

[10]

QUESTION 3 (Start on a new page.)

3.1 Tom is pushing and Zane is pulling a trolley, loaded with crushed stone, over a rough surface on a construction site. The mass of the trolley and its contents is 350 kg. Tom pushes with a force of 200 N and Zane pulls with a force of 160 N using a string, which makes an angle of 65° with the horizontal, as shown in the diagram below.



3.1.1 Define *tension force*, and give an example of such a force in the diagram above. (3)

3.1.2 How will the frictional force on the trolley be affected by Zane's applied force? Write only INCREASES, DECREASES or REMAINS CONSTANT. (2)

3.1.3 Draw a free-body diagram of ALL the forces acting on the trolley and its contents. (5)

3.2 If the net force acting on the trolley and its contents is 205 N, calculate the coefficient of kinetic friction (μ_k) between the surface and the trolley. (6)

[16]

QUESTION 4 (Start on a new page.)

4.1 An electrician, rushing to an urban area with a power outage, drives a truck of mass 1 350 kg towards the east travelling at 120 $km.h^{-1}$. The truck collides head-on with a car of mass 1 050 kg travelling at 16,67 $m.s^{-1}$.

4.1.1 Define *momentum*. (2)

4.1.2 What is the velocity of the truck before the collision in $m.s^{-1}$? (2)

4.1.3 Calculate the initial momentum of the car. (3)

4.2 After the collision, the truck continues to move towards the east at 20,3 $m.s^{-1}$ and the car moves backwards at 5,32 $m.s^{-1}$. The system is isolated.

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

4.2.2 Use a calculation to determine whether the collision was elastic or inelastic. (5)

4.3 The driver of a car with a mass of 1 150 kg crashes into a tree with a velocity of 15 $m.s^{-1}$ as shown in the diagram below. The car comes to rest after the crash. The car experiences a constant net force of 57 500 N before it comes to rest.

4.3.1 What is the relationship between the net force experienced by the car and the contact time during the crash? (2)

4.3.2 How does the impulse experienced by the car compare to its change in momentum? Write only SMALLER THAN, GREATER THAN or EQUAL TO. (1)

4.3.3 The car is equipped with airbags. Explain, using impulse, how this would reduce the extent of the driver's injuries. (3)

4.3.4 Calculate the contact time during the crash. (4)

[24]

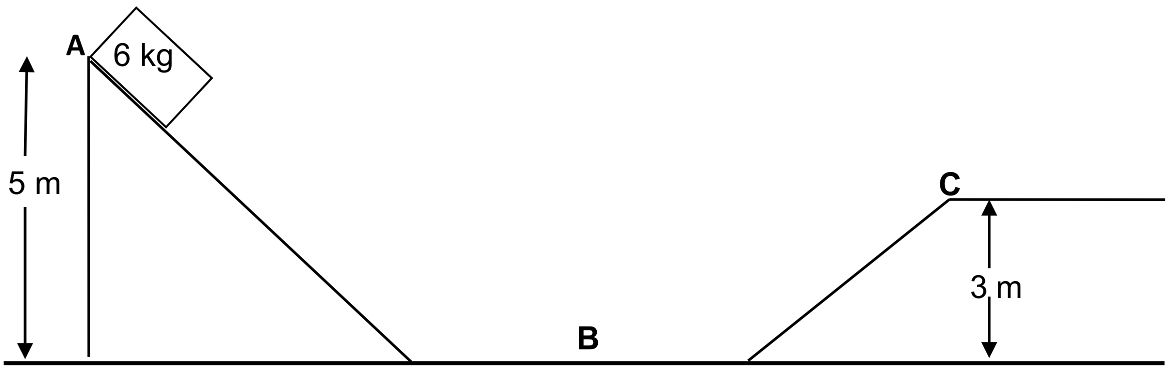
QUESTION 5 (Start on a new page.)

5.1 A learner lifts her school bag straight from the ground to a height of 0,9 m above the ground. She applies a force of 25 N to lift the bag. Ignore the effect of air resistance.

5.1.1 Calculate the work done by the learner. (3)

5.1.2 If the mass of the bag is 2 kg, determine the net work done on the bag. (4)

5.2 The diagram below represents a frictionless track. A 6 kg block starts from rest at point **A** and slides along the track.



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

5.2.2 Calculate the mechanical energy of the block at point **A**. (4)

5.2.3 What will be the speed of the block at point **B**? (4)

5.2.4 Calculate the speed of the block at point **C**. (4)
[21]

QUESTION 6 (Start on a new page.)

6.1 Define the following terms:

6.1.1 Stress (2)

6.1.2 Strain (2)

6.2 A steel bar experiences a stress of 250 MPa. The modulus of elasticity is 190 GPa. The bar has a diameter of 60 mm and is 220 mm long.

Calculate the:

6.2.1 Strain on the bar (3)

6.2.2 Force exerted on the bar (4)

6.3 What is the effect of an increase in temperature on the viscosity of a fluid? (2)

6.4 Define a *perfectly plastic body*. (2)

6.5 Give TWO examples of perfectly plastic bodies. (2)

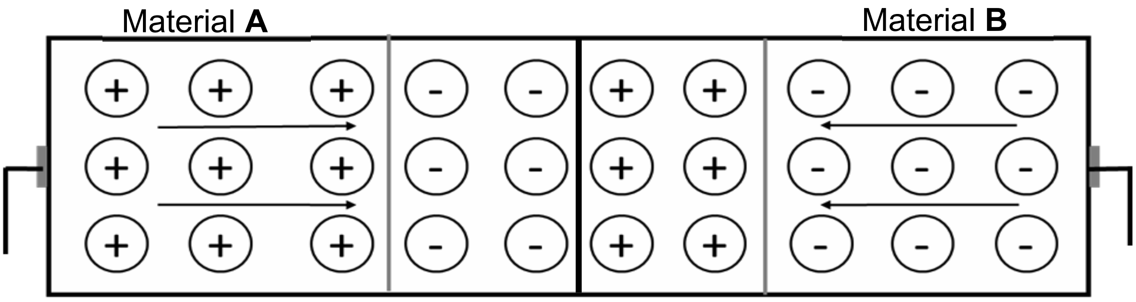
6.6 State Pascal's law in words. (2)

6.7 A hydraulic system is used to lift a 20 000 N vehicle in a workshop. If the vehicle sits on a piston of area 0,8 m^2, and a force is applied to another piston of 0,05 m^2, what is the minimum force that must be applied to lift the vehicle? (4)

6.8 Define the *thrust* of a liquid. (2)
[25]

QUESTION 7 (Start on a new page.)

7.1 This diagram represents a p-n junction diode.



7.1.1 Name the type of material indicated by **A** and **B**. (2)

7.1.2 Draw the symbol for this p-n junction diode. (2)

7.1.3 How many valence electrons does an intrinsic semiconductor have? (1)

7.2 Define a *capacitor*. (2)

7.3 State the relationship between the capacitance and the charge on the plates. (2)

7.4 State TWO changes that you can make to the capacitor to decrease the capacitance. (2)

7.5 A lamp filament has a resistance of 60 Ω and draws a current of 2 A when connected across a 120 V supply. Calculate the cost of electricity consumed in two hours, if the tariff is R1,75 per kWh. (7)

[18]

QUESTION 8 (Start on a new page.)

8.1 Define *electromagnetic induction*. (2)

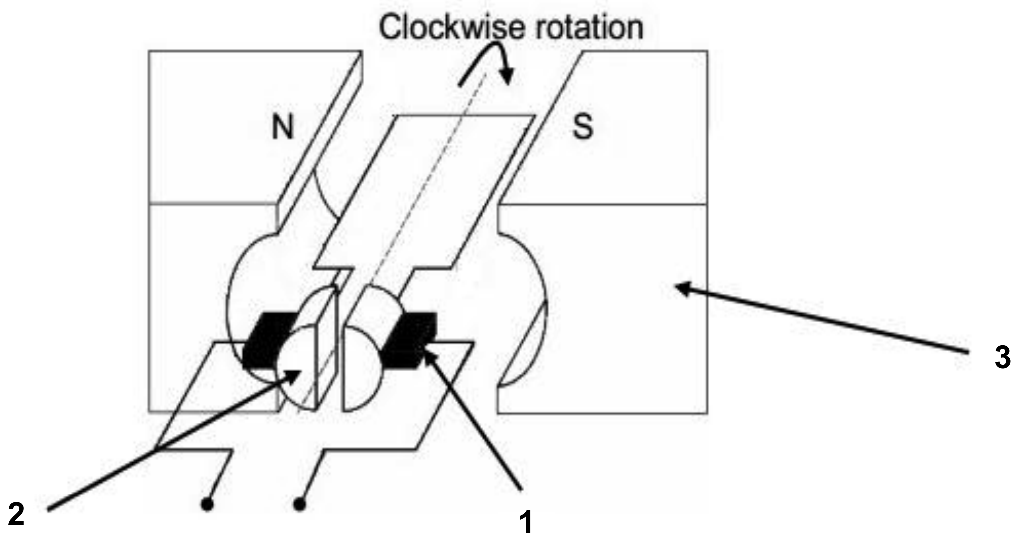
8.2 Name TWO factors that influence the induced emf. (2)

8.3 State Lenz's law in words. (2)

8.4 Give THREE examples where Lenz's law is applied. (3)
[9]

QUESTION 9 (Start on a new page.)

9.1 Study the diagram of a motor below and answer the questions that follow.



9.1.1 Label parts **1**, **2** and **3**. (3)

9.1.2 Identify the type of motor. (1)

9.2 A transformer has 1 200 turns on the primary coil, 110 turns on the secondary coil and the secondary voltage is 20 V. Determine the primary voltage. (3)
[7]

TOTAL: 150

DATA FOR TECHNICAL SCIENCES GRADE 12
PAPER 1

GEGEWENS VIR TEGNIESE WETENSKAPPE GRAAD 12
VRAESTEL 1

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m\cdot s^{-2}$
Permittivity of free space Permittiwiteit van vry ruimte	ε_o	$8,85 \times 10^{-12}\ F.m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$F_g = mg$

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* $E_k = \frac{1}{2}mv^2$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	$M_E = E_k + E_p$

ELASTICITY, VISCOSITY AND HYDRAULICS/*ELASTISITEIT, VISKOSITEIT EN HIDROULIKA*

$\sigma = \frac{F}{A}$ / $\text{Stress} = \frac{\text{Force}}{\text{Area}}$ $\text{Spanning} = \frac{\text{Krag}}{\text{Area}}$	$\varepsilon = \frac{\Delta \ell}{L}$ / $\text{Strain} = \frac{\text{change in length}}{\text{original length}}$ $\text{Vervorming} = \frac{\text{verandering in lengte}}{\text{oorspronklike lengte}}$
$P = \rho gh$	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$
$\frac{\sigma}{\varepsilon} = K$ / $\text{modulus of elasticity} = \frac{\text{stress}}{\text{strain}}$ $\text{modulus van elastisiteit} = \frac{\text{spanning}}{\text{vervorming}}$	$\text{Pressure (P)} = \frac{\text{Force(F)}}{\text{Area}}$ $\text{Druk (P)} = \frac{\text{Krag(F)}}{\text{Area}}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$C = \frac{Q}{V}$	$C = \frac{\varepsilon_o A}{d}$

CURRENT ELECTRICITY/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ $R_P = \frac{R_1 x R_2}{R_1 + R_2}$	$q = I \Delta t$
$W = VQ$ $W = VI \Delta t$ $W = I^2 R \Delta t$ $W = \frac{V^2 \Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2 R$ $P = \frac{V^2}{R}$

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

$\phi = BA$	$\varepsilon = -N \frac{\Delta \phi}{\Delta t}$
$\frac{V_s}{V_p} = \frac{N_s}{N_p}$	

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/*SENIOR SERTIFIKAAT*
NATIONAL SENIOR CERTIFICATE/
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

TECHNICAL SCIENCES P1/
TEGNIESE WETENSKAPPE V1

NOVEMBER 2020

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

APPROVED DBE IM 03/12/2020
APPROVED DBE IM 03/12/2020

These marking guidelines consist of 15 pages
Hierdie nasienriglyne bestaan uit 15 bladsye.

Approved: Umalusi
03/12/2020

DEPARTMENT OF BASIC EDUCATION
PRIVATE BAG X895, PRETORIA 0001
2020 -12- 03
APPROVED MARKING GUIDELINE
PUBLIC EXAMINATION

QUESTION 1/*VRAAG 1*

1.1	D	✓✓	(2)
1.2	D	✓✓	(2)
1.3	A	✓✓	(2)
1.4	B	✓✓	(2)
1.5	B	✓✓	(2)
1.6	A	✓✓	(2)
1.7	B	✓✓	(2)
1.8	B	✓✓	(2)
1.9	A	✓✓	(2)
1.10	C	✓✓	(2)

[20]

QUESTION 2/*VRAAG 2*

2.1 An object continues in a state of rest or uniform (moving with constant) velocity ✓ unless it is acted upon by a net (resultant) force ✓.

OR

An object will remain at rest or continue moving at a constant velocity ✓ unless a non-zero resultant /net force acts on it. ✓

'n Voorwerp sal volhard in sy toestand van rus (of uniforme snelheid) tensy 'n net (resulterende) krag daarop inwerk.

OF

'n Liggaam sal in sy toestand van rus of uniforme snelheid (beweeg teen konstante snelheid) volhard tensy 'n ongebalanseerde krag/(netto of resulterende krag) daarop inwerk. (2)

2.2

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**
$F_{net} = ma$ $F_{net} = 0\ N$ $F_{net} = F \cos 40° + f_k$ $F \cos 40° + f_k = 0\ N$ $F_{net} = F_H + f_k$ $F_H + f_k = 0\ N$ Any one ✓	$F_{net} = ma$ $F_{net} = 0\ N$ $F_{net} = F \cos 40° + f_k$ $F \cos 40° + f_k = 0\ N$ $F_{net} = F_H + f_k$ $F_H + f_k = 0\ N$ Any one ✓
(Choose right to be positive) *(Kies regs as positief)*	(Choose left to be positive) *(Kies links as positief)*
$F \cos 40° + f_k = 0$ $80 \cos 40° + f_k = 0$ ✓ $61{,}28 + f_k = 0$ $f_k = -61{,}28$ $f_k = 61{,}28\ N$ ✓ (to the left) *(na links)*	$F \cos 40° + f_k = 0$ $-80 \cos 40° + f_k = 0$ ✓ $-61{,}28 + f_k = 0$ $f_k = 61{,}28\ N$ ✓ (to the left) *(na links)*

(3)

2.3.1 Inertia is a property/tendency of an object/body to resist a change ✓ in its state of rest or motion ✓ (in a straight line).

Traagheid is die eienskap van 'n voorwerp om die verandering in sy toestand van rus of beweging teen te staan. (2)

2.3.2 **Apply Negative marking/*Pas negatiewe nasien toe***

Increase. ✓

Inertia of an object is directly proportional to its mass. ✓

When the mass of an object increases, its inertia also increases. ✓

Verhoog

Traagheid van 'n voorwerp is direk eweredig aan sy massa.

Indien die massa van 'n voorwerp verhoog, sal die traagheid ook verhoog. (3)

[10]

MD

BP

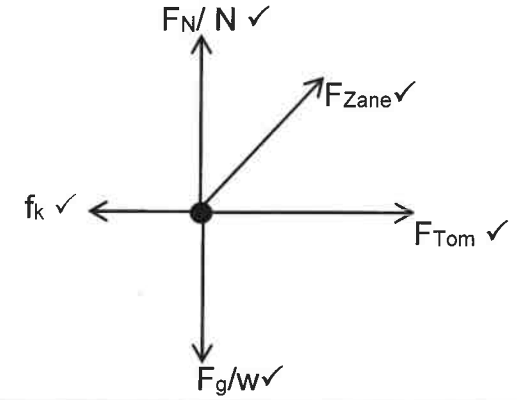
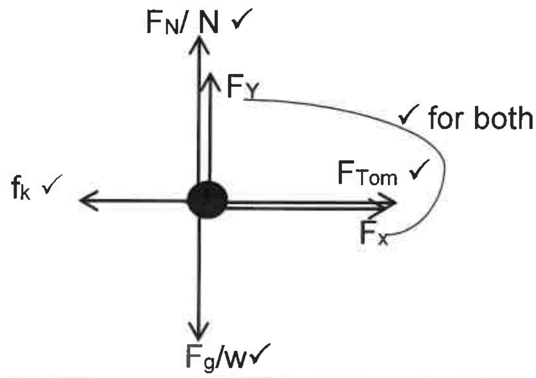
QUESTION 3/*VRAAG 3*

3.1.1
- Tension is a (pulling) force acting in a string or rope. ✓✓
- Force applied by Zane (F_{Zane})/F_{160}/160 N ✓

- *Spanning is 'n (trek)krag wat in 'n ketting of tou werk.*
- *Krag toegepas deur Zane* (F_{Zane})/F_{160}/160 N (3)

3.1.2 Decrease ✓✓/*Verlaag* (2)

3.1.3

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

ACCEPTABLE LABELS: ***AANVAARBARE BYSKRIFTE:***	**NOTE:** ***LET OP:***
• F_g/w/weight/*Gewig* • f_k/*f*/friction/*Wrywing* • F_{Tom}/ F_{200}/ 200 N/Force by Tom/*Krag van Tom* • F_{Zane}/ Force by Zane/F_{160}/160 N/Tension /T/*Krag van Zane* • F_N/N/Normal force/*Normaalkrag* • F_Y/F_V/Vertical component of force by Zane/*Vertikale komponent van krag deur Zane* • F_X/F_H/ Horizontal component of force by Zane/*Horisontale komponent van krag deur Zane* • F_A /F_{zane}/F_{Tom}	Penalise once if • Force diagram used • Arrows are not shown • If force does not touch the dot • An additional force • Using broken lines *Penaliseer eenmalig indien:* • *Pyle nie aangedui nie* • *Kragtediagram geteken* • *Die krag raak nie die kol nie* • *Voeg 'n addisionele krag by* • *Gebruik stippellyne*

(5)

3.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
Choose east to be positive *Kies oos as positief* $\left.\begin{array}{l}F_{net} = F_x + F_{Tom} + f_k \\ F_{net} = F_{Zane} \text{Cos } 65° + F_{Tom} + f_k\end{array}\right\}$ ✓ $\underline{205 = 200}$✓ + $\underline{160 \text{ Cos } 65°}$✓ + f_k f_k = - 62,62 N $\left.\begin{array}{l}f_k = \mu_k N \\ f_k = \mu_k (F_g - F_{Zane} \text{Sin } 65°) \\ f_k = \mu_k (\underline{mg - F_{Zane} \text{Sin } 65°})\end{array}\right\}$ Any one 62,62 = μ_k (350 x 9,8 – 160 Sin 65°) ✓ 62,62 = μ_k (3284,99) μ_k = 0,019/ 0,02 ✓	$\left.\begin{array}{l}F_{net} = F_x + F_{Tom} + f_k \\ F_{net} = F_{Zane} \text{Cos } 65° + F_{Tom} + f_k\end{array}\right\}$ ✓ $\underline{205 = 200}$✓ + $\underline{160 \text{ Cos } 65°}$✓ + f_k f_k = - 62,62 N N = F_g - F_{Zane} Sin 65) = $\underline{mg - F_{Zane} \text{Sin } 65°}$) = 350 x 9,8 – 160 Sin 65° ✓ = 3284,99 N $f_k = \mu_k$ N ✓ 62,62 = μ_k (3284,99) μ_k = 0,019/ 0,02 ✓

OPTION 3/*OPSIE 3*
Choose east to be positive *Kies oos as positief* $f_k = \mu_k$ N ✓ $\underline{F_{net} – (F_{Zane} \text{Cos } 65° + F_{Tom})}$ ✓= μ_k N F_{net} – (F_{Zane} Cos 65° + F_{Tom}) = μ_k ($\underline{mg - F_{Zane} \text{Sin } 65°}$) $\underline{205 – 200}$ ✓ $\underline{– 160 \text{ Cos } 65°}$ ✓ = μ_k ($\underline{350 \times 9,8 – 160 \text{ Sin } 65°}$) ✓ - 62,62 = μ_k (3284,99) (Ignoring direction/*Ignoreer rigting*) 62,62 = μ_k (3284,99) μ_k = 0,019 /0,02 ✓

(6)
[16]

QUESTION 4/*VRAAG 4*

4.1.1 Momentum (of an object) is the product of the object's mass ✓ and its velocity (in a straight line). ✓

Momentum (van 'n voorwerp) is die produk van die voorwerp se massa en sy snelheid (in 'n reguitlyn.) (2)

4.1.2

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**
$v_{i\ truck/bakkie} = 120 \times \frac{1000}{3600}$ $= 33{,}33\ m.s^{-1}$ ✓, east ✓	$v_{i\ truck/bakkie} = 120 \times \frac{1}{3{,}6}$ $= 33{,}33\ m.s^{-1}$ ✓, east ✓

(2)

4.1.3 $p = m_{car} v_{i\ car}$ ✓
$= 1\ 050 \times 16{,}67$ ✓
$= 17\ 503{,}5\ kg.m.s^{-1}$, west/*wes* ✓ (3)

4.2.1 The total linear momentum of an isolated system✓ remains constant✓ (is conserved) in magnitude and direction.

Die totale liniêre momentum in 'n geïsoleerde sisteem is konstant.

OR/*OF*

The total linear momentum of an isolated system✓ before collision/explosion is equal to total linear momentum after collision/explosion✓.

In 'n geïsoleerde sisteem, is die totale liniêre momentum voor die botsing gelyk aan die totale liniêre momentum na die botsing. (2)

4.2.2 **POSITIVE MARKING FROM 4.1.2/*POSITIEWE NASIEN VAN 4.1.2***

$$\sum E_{ki} = \frac{1}{2}m_{truck/bakkie}v_{i\ truck/bakkie}^2 + \frac{1}{2}m_{car}v_{i\ car}^2 \checkmark$$
$$= \frac{1}{2}(1\ 350)(33{,}33)^2 + \frac{1}{2}(1\ 050)(-16{,}67)^2 \checkmark$$
$$= 895\ 741{,}68\ J$$

$$\sum E_{kf} = \frac{1}{2}m_{truck/bakkie}v_{f\ truck/bakkie}^2 + \frac{1}{2}m_{car}v_{f\ car}^2$$
$$= \frac{1}{2}(1\ 350)(20{,}3)^2 + \frac{1}{2}(1050)(5{,}32)^2 \checkmark$$
$$= 293\ 019{,}51\ J$$

$\sum E_{ki} \neq \sum E_{kf}$/(Kinetic energy is not conserved/*Kinetiese energie nie behoue nie*) ✓
Therefore, collision was inelastic ✓ / *Die botsing was dus onelasties.*

NOTE: If a learner starts: $\sum E_{ki} = \sum E_{kf}$ take 1 mark/ *Indien leerder met* $\sum E_{ki} = \sum E_{kf}$ begin gee 1 punt (5)

4.3.1 Inversely proportional. ✓✓ /*Omgekeerd eweredig*

OR

$F_{net} \propto \frac{1}{\Delta t}$ (2)

OR

When the contact time increases/decrease, the net force decreases/increase.

Wanneer die kontaktyd verhoog, sal die netto krag verlaag.

NOTE/NB: GIVE full mark for mathematical expression/*Gee volpunte vir wiskundige uitdrukking*

4.3.2 Equal to ✓
Gelyk aan (1)

4.3.3
- Impulse remains constant. ✓
- Airbags increase the contact time during the crash. ✓
- The longer the contact time, the smaller the force ✓ exerted by the driver on the car and the lesser is the extent of injuries.

- *Impuls bly konstant.*
- *Lugsakke verleng die kontaktyd tydens die botsing.*
- *Hoe langer die kontaktyd, hoe kleiner die krag wat deur die drywer op die motor uitgeoefen word en hoe minder die beserings.* (3)

4.3.4

OPTION/*OPSIE* 1	**OPTION/*OPSIE* 2**
Let the direction towards the tree be positive ***Neem die rigting na die boom as positief*** $\left.\begin{array}{l}F_{net}\Delta t = \Delta p \\ F_{net}\Delta t = m(v_f - v_i)\end{array}\right\}$ ✓ for any $-57\ 500\Delta t$ ✓ $= 1\ 150(0 - 15)$ ✓ $\Delta t = 0{,}30$ s ✓	**Let the direction towards the tree be negative** ***Neem die rigting na die boom as negatief*** $F_{net}\Delta t = \Delta p$ $F_{net}\Delta t = m(v_f - v_i)$ $57\ 500\Delta t$ ✓ $= 1\ 150\{0 - (-15)\}$ ✓ $\Delta t = 0{,}30$ s ✓

(4)
[24]

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QUESTION 5/*VRAAG 5*

5.1.1 $W_{learner/leerder} = F_{app}\ \Delta y \cos\theta$ ✓

$= (25)(0,9)\underline{(\cos 0°)}$
$= (25)(0,9)\underline{(1)}$ ✓ for any
$= 22,5$ J ✓ (3)

5.1.2

<table>
<tr><td>OPTION 1/OPSIE 1</td><td>OPTION 2/OPSIE 2</td></tr>
<tr><td>Choose up to be positive
Kies op as positief

$F_{net} = F_a + F_g$
$F_{net} = F_a + mg$
$= 25 + 2(-9,8)$ ✓
$= 5,4$ N

$W_{net} = F_{net}\Delta y \cos\theta$ ✓
$= \underline{(5,4)\ (0,9)(\cos 0°)}$
$= (5,4)(0,9)(1)$ ✓ for any
$= 4,86$ J ✓</td><td><u>Positive marking from 5.1.1</u>
<u>Merk positief vanaf 5.1.1</u>

$W_g = F_g\,\Delta y \cos\alpha$
$= mg\ \Delta y \cos\alpha$
$= (2)(9.8)(0,9)(\cos 180°)$
$= (2)(9.8)(0,9)(-1)$ ✓ for any
$= -17,64$ J

$W_{net} = W_{learner/leerder} + W_g$ ✓
$= \underline{22,5\ + (-17,64)}$ ✓
$= 4,86$ J✓</td></tr>
<tr><td>OPTION 3/OPSIE 3</td><td>OPTION 4/ OPSIE 3</td></tr>
<tr><td>$W_{net} = F_{net}\Delta y \cos\theta$
$= (F_a + mg)\ \Delta y \cos\theta$ ✓ for any
$= \{\underline{25 + 2(-9,8)}$ ✓$\}\ \underline{(0,9)(\cos 0°)}$ ✓
$= (5,4)(0,9)(1)$
$= 4,86$ J ✓</td><td>$W_{net} = W_{learner/leerder} + W_g$
$= W_{learner/leerder} + mg\ \Delta y \cos\alpha$ ✓ for any
$= \underline{22,5}$ ✓$+ \underline{(2)(9.8)(0,9)(\cos 180°)}$ ✓
$= 22,5 + (2)(9.8)(0,9)(-1)$
$= 4,86$ J ✓</td></tr>
</table>

(4)

5.2.1 The total mechanical energy of an isolated system✓ is constant. ✓
OR
The sum of gravitational potential energy and kinetic energy in an isolated system remains constant.

Die totale meganiese energie in 'n geïsoleerde sisteem bly konstant.
OF
Die som van die gravitasionele potensiele en kinetiese energie bly konstant in 'n geisoleerde sisteem. (2)

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MD
BP

5.2.2

OPTION 1/*OPSIE* 1	OPTION 2/*OPSIE* 2
$M_E = E_p + E_k$ $= mgh + \frac{1}{2}mv^2$ ✓ for any one $= \underline{(6)(9,8)(5)}$ ✓ $+ \frac{1}{2} \times 6 \times 0^2$ ✓ $= 294$ J ✓ **Accept/Aanvaar:** 0 for $\frac{1}{2} \times 6 \times 0^2$	$E_k = \frac{1}{2}mv^2$ $= \frac{1}{2} \times 6 \times 0^2$ ✓ $= 0$ J $E_p = mgh$ $= \underline{(6)(9,8)(5)}$ ✓ $= 294$ J $M_E = E_p + E_k$ ✓ $= 294 + 0$ $= 294$ J ✓

(4)

5.2.3 **POSITIVE MARKING FROM 5.2.2**
POSITIEWE MERK VANAF 5.2.2

OPTION 1/*OPSIE* 1	OPTION 2/*OPSIE* 2
In an isolated system/ *In 'n geisoleerde sisteem* $E_{p(Top)} = E_{k(Bottom)}$ **NOTE/NB:** If the above statement is omitted, learner will lose 1 mark/*Indien bogenoemde stelling nie ingesluit is nie sal leerder 1 punt verloor.* $E_k = \frac{1}{2}mv^2$ ✓ 294 ✓ $= \frac{1}{2}(6)(v^2)$ ✓ $v^2 = 98$ $v = 9,90$ m.s^{-1} ✓	$M_{E(A)} = M_{E(B)}$ $M_{E(A)} = (E_p + E_k)_B$ $M_{E(A)} = (mgh + \frac{1}{2}mv^2)_B$ ✓ for any 294 ✓ $= 0 + \frac{1}{2}(6)(v^2)$ ✓ $v^2 = 98$ $v = 9,90$ m.s^{-1} ✓

(4)

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MD
B.P.

5.2.4 **POSITIVE MARKING FORM 5.2.2/*POSITIEWE NASIEN VANAF 5.2.2***

OPTION 1/*OPSIE* 1

$$\left.\begin{aligned} M_E &= E_k + E_p \text{ (At C)} \\ E_k \text{ at C} &= M_E - E_p \text{ at C} \\ &= M_E - mgh \end{aligned}\right\} \checkmark \text{ for any one}$$

$$= 294 - (6 \times 9{,}8 \times 3) \checkmark$$
$$= 294 - 176{,}4$$
$$= 117{,}6 \text{ J}$$

$\frac{1}{2}mv^2 = 117{,}6$ at point C /*by punt C*

$$\frac{1}{2}(6)v^2 = 117{,}6 \checkmark$$
$$v^2 = 39{,}2$$
$$v = 6{,}26 \text{ m.s}^{-1} \checkmark$$

(4)

OPTION 2/*OPSIE* 2

$$\left.\begin{aligned} M_E \text{ (At B)} &= M_E \text{ (At C)} \\ \frac{1}{2}mv^2 + mgh \text{ (At B)} &= \frac{1}{2}mv^2 + mgh \text{ (At C)} \end{aligned}\right\} \checkmark \text{ for any one}$$

$$\frac{1}{2}(6)(9{,}9)^2 + (6)(9{,}8)(0) \checkmark = \frac{1}{2}(6)(v)^2 + (6)(9{,}8)(3) \checkmark$$
$$294 = 3(v)^2 + 176{,}4$$
$$v^2 = 39{,}2$$
$$v = 6{,}26 \text{ m.s}^{-1} \checkmark$$

OPTION 3/ *OPSIE* 3

$$\left.\begin{aligned} M_E \text{ (At A)} &= M_E \text{ (At C)} \\ \frac{1}{2}mv^2 + mgh \text{ (At A)} &= \frac{1}{2}mv^2 + mgh \text{ (At C)} \end{aligned}\right\} \checkmark \text{ for any}$$

$$\frac{1}{2}(6)(0)^2 + (6)(9{,}8)(5) \checkmark = \frac{1}{2}(6)(v)^2 + (6)(9{,}8)(3) \checkmark$$
$$294 = 3(v)^2 + 176{,}4$$
$$v^2 = 39{,}2$$
$$v = 6{,}26 \text{ m.s}^{-1} \checkmark$$

[21]

QUESTION 6/*VRAAG 6*

6.1.1 Stress is the internal restoring force per unit area of body✓✓.

Spanning is die interne herstelkrag per oppervlakte eenheid van 'n voorwerp. (2)

6.1.2 Strain is the ratio of change in dimension/length to the original dimension/length.✓✓

Vervorming is die verhouding van verandering in dimensie tot die oorspronklike dimensie. (2)

6.2.1

$$K = \frac{\sigma}{\varepsilon} \checkmark$$

$$190 \times 10^{9} = \frac{250 \times 10^{6}}{\varepsilon} \checkmark$$

$$\varepsilon = 1{,}32 \times 10^{-3} / 0{,}00132 \checkmark$$

(3)

6.2.2

OPTION 1/*OPSIE 1*	**OPTION2/*OPSIE 2***
$\text{Area} = \frac{\pi d^2}{4}$ $\text{Area} = \frac{\pi(0{,}06)^2}{4} \checkmark$ $= 2{,}827433 \times 10^{-3} m^2$ $\sigma = \frac{F}{A} \checkmark$ $250 \times 10^{6} = \frac{F}{2{,}8274333 \times 10^{-3}} \checkmark$ $F = 706\ 858{,}35\ N \checkmark$ **ACCEPT:** 706 500 N OR 707 500 N ***AANVAAR:*** 706 500 N OF 707 500 N	$\text{Area} = \pi r^2$ $\text{Area} = \pi(0{,}03)^2 \checkmark$ $= 2{,}827433 \times 10^{-3}\ m^2$ $\sigma = \frac{F}{A} \checkmark$ $250 \times 10^{6} = \frac{F}{2{,}8274333 \times 10^{-3}} \checkmark$ $F = 706\ 858{,}35\ N \checkmark$ **ACCEPT:** 706 500 N OR 707 500 N **AANVAAR:***706 500 N OF 707 500 N*

(4)

6.3 As the temperature increases, (viscosity of a fluid) decreases. ✓✓

Soos die temperatuur styg, verlaag die viskositeit (van 'n vloeistof). (2)

6.4 A body which does not show a tendency to regain its original shape and size✓ when the deforming force is removed. ✓

'n Voorwerp wat nie neig om sy oorspronklike vorm en grootte te herwin wanneer die vervormingskrag verwyder word nie. (2)

MD

B-P.

6.5
- Clay ✓
- Wax ✓
- Putty
- Aluminium
- Mild Steel

Any two and any other correct one
Enige twee en enige ander korrekte antwoord

- *Klei*
- *Was*
- *Stopverf*
- *Aluminium*
- Sagte staal

(2)

6.6 In a continuous liquid at equilibrium, the pressure applied at any point is transmitted equally to other parts of the liquid. ✓✓

In 'n kontinue vloeistof by ewewig, sal die druk wat by enige punt toegepas word eweredig na ander dele van die vloeistof versprei word. (2)

6.7

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\frac{F_1}{A_1} = \frac{F_2}{A_2}$ ✓ $\frac{F_1}{0,05}$ ✓ $= \frac{20\,000}{0,8}$ ✓ $F_1 = 1\,250$ N ✓ **NOTE**: Give full marks if F_2 is calculated. *Gee vol punte indien F_2 bereken was.*	$P_2 = \frac{F_2}{A_2}$ $P_2 = \frac{20\,000}{0,8}$ ✓ $P_2 = 25\,000$ Pa $P_2 = 25 \times 10^3$ Pa $P_2 = 25$ kPa ✓ for both/ *Vir beide* But $P_1 = P_2$, then $P_1 = \frac{F_1}{A_1}$ $25 \times 10^3 = \frac{F_1}{0,05}$ ✓ $F_1 = 1\,250$ N ✓

(4)

6.8 The normal force exerted by a liquid at rest on a given surface in contact with it. ✓✓

Die normaalkrag/stukrag wat deur 'n vloeistof in rus uitgeoefen word op 'n oppervlakte waarmee dit in kontak is. (2)
[25]

QUESTION 7/*VRAAG 7*

7.1.1 **A** is the p-type/ Positive type (semiconductor) ✓
B *is an n-type/* Negative type *(semiconductor)*✓

A *is die p-tipe (halfgeleier)*
B *is die n-tipe (halfgeleier)* (2)

7.1.2

✓✓

ACCEPT: If the arrow is not shaded
AANVAAR*: Indien die pyl nie ingekleur is nie.* (2)

7.1.3 Four/4 ✓ / *Vier/4* (1)

7.2 A device that stores electrical charge. ✓✓
'n Toestel wat elektriese lading stoor. (2)

7.3 The capacitance is directly proportional to the charge between the plates. ✓✓
OR
$C \propto Q$
Die kapasitansie is direk eweredig aan die lading tussen die plate. (2)

7.4
- Decrease surface area of the plates. ✓
- Increase distance between the plates.✓
- Use dielectric material with a low dielectric constant/ permittivity.
- *Verminder die plaatoppervlakte*
- *Verhoog die afstand tussen die plate.*
- *Gebruik diëlektriese stof met n lae diëlektriese konstante/lae permitiwiteit* (2)

7.5

OPTION 1/*OPSIE 1*	OPTION 2/*OPSIE 2*	OPTION 3/*OPSIE 3*
$P = \frac{V^2}{R}$ ✓ $P = \frac{120^2}{60}$ ✓ $P = 240\ W$ $P = 0{,}24\ kW$ Energy used: $E = Pt$ ✓ $E = 0{,}24 \times 2$ ✓ $E = 0{,}48\ kWh$ Cost of energy used: Cost = E used x tariff✓ Cost = 0,48x1,75 ✓ Cost = R0,84 ✓	$P = VI$ ✓ $P = 120 \times 2$ ✓ $P = 240\ W$ $P = 0{,}24\ kW$ Energy used: $E = Pt$ ✓ $E = 0{,}24 \times 2$ ✓ $E = 0{,}48\ kWh$ Cost of energy used: Cost = E used x tariff✓ Cost = 0,48x1,75 ✓ Cost = R0,84 ✓	$P = I^2R$ ✓ $P = 2^2 \times 60$ ✓ $P = 240\ W$ $P = 0{,}24\ kW$ Energy used $E = Pt$ ✓ $E = 0{,}24 \times 2$ ✓ $E = 0{,}48\ kWh$ Cost of energy used: Cost = E used x tariff✓ Cost = 0,48x1,75 ✓ Cost = R0,84 ✓

(7)

OPTION 4	OPTION 5	OPTION 6
$W = \frac{V^2\Delta t}{R}$ ✓ $= \frac{(120^2)✓(2)}{60}$ ✓ = 480 W = 0,48 kWh ✓ Cost = E_{used} x tariff ✓ = (0,48)(1,75) ✓ = R0,84 ✓	$W = VI\Delta t$ ✓ = (120)(2) ✓(2) ✓ = 480 W = 0,48 kWh ✓ Cost = E_{used} x tariff ✓ = (0,48)(1,75) ✓ = R0,84 ✓	$W = I^2R\Delta t$ ✓ = $(2^2)(60)$ ✓ (2) ✓ = 480 W = 0,48 kWh ✓ Cost = E_{used} x tariff ✓ = (0,48)(1,75) ✓ = R0,84 ✓

[18]

QUESTION 8/*VRAAG 8*

8.1 This is the process of generating electricity from motion. ✓✓
OR
The production of an emf or voltage across an electrical conductor due to relative motion between the conductor and magnetic field.

Dit is die proses om elektrisiteit op te wek deur beweging.
OF
Die opwekking van 'n emk of spanning oor n geleier deur relatiewe beweging tussen die geleier en magneetveld. (2)

8.2
- The strength of the magnetic field. ✓
- The number of turns on the coil. ✓
- The speed at which the magnet and coil are moved relative to each other.

(ANY TWO)

- *Die sterkte van die magneetveld.*
- *Die aantal windings op die spoel.*
- *Die spoed waarteen die magneet en die spoel relatief tot mekaar beweeg word.*

(ENIGE TWEE) (2)

8.3 (Lenz's law states that) the direction of the induced emf (in the coil) opposes the effect that produces it. ✓✓
(Lenz se wet sê) dat die rigting van die geïnduseerde emk (in die spoel) die effek teenwerk wat dit opgewek het. (2)

8.4
- Electromagnetic braking in trains/rotating machinery. ✓
- Electric motors✓
- Electric generators. ✓
- Induction cooking pots where the pot is heated by magnetic induction.
(ACCEPT ANY OTHER CORRECT APPLICATIONS)
- *Elektromagnetiese remme in treine/roterende masjiene.*
- *Elektriese motors*
- *Generators.*
- *Induksiepotte waar die potte deur magnetiese induksie verhit word.*
(AANVAAR ENIGE ANDER KORREKTE TOEPASSINGS)

(3)
[9]

MD B.P

QUESTION 9/*VRAAG 9*

9.1.1 **1** – (carbon) brushes✓
2 – commutator/ split ring ✓
3 – magnet ✓

1 *– borsels*
2 *– kommutator/ spleetring*
3 *– magneet* (3)

9.1.2 DC motor ✓
GS motor (1)

9.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ ✓	$\frac{V_P}{V_S} = \frac{N_P}{N_S}$ ✓
$\frac{20}{V_P} = \frac{110}{1\,200}$ ✓	$\frac{V_P}{20} = \frac{1\,200}{110}$ ✓
$V_P = \frac{1\,200 \times 20}{110}$	$V_P = \frac{1\,200 \times 20}{110}$
$V_P = 218{,}18$ V ✓	$V_P = 218{,}18$ V ✓

(3)
[7]

TOTAL/*TOTAAL*: 150

MD
B.P.