Province of the
EASTERN CAPE
EDUCATION

EXAMINATIONS AND ASSESSMENT CHIEF DIRECTORATE
Home of Examinations and Assessment, Zone 6, Zwelitsha, 5600
REPUBLIC OF SOUTH AFRICA, Website: www.ecdoe.gov.za

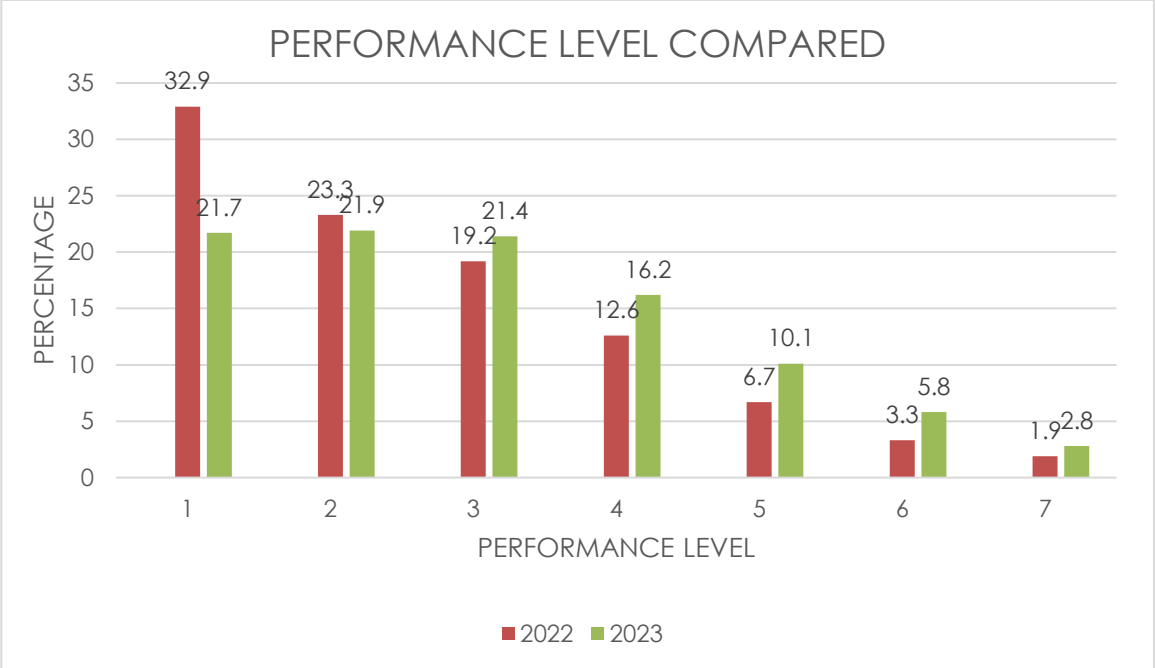
2023 NSC CHIEF MARKER'S REPORT

SUBJECT	**PHYSICAL SCIENCES**
QUESTION PAPER	ONE
DURATION OF QUESTION PAPER	3 HOURS
PROVINCE	EASTERN CAPE
DATES OF MARKING	4/12/23 TO 18/12/23

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

Generally, learners performed is poorly, the pass rate overall is 78%. Even though the pass rate is above average, the quality passes is very low. Only 34,9% obtained above 50% (level 4) a requirement for admonition into the universities.

LEVELS	PERCENTAGE PERFOMANCE (%)	
	2022	**2023**
1	32,9	21,7
2	23,3	21,9
3	19,2	21,4
4	12,6	16,2
5	6,7	10,1
6	3,3	5,8
7	1,9	2,8



SECTION 2: Comment on candidates' performance in individual question.

QUESTION 1

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

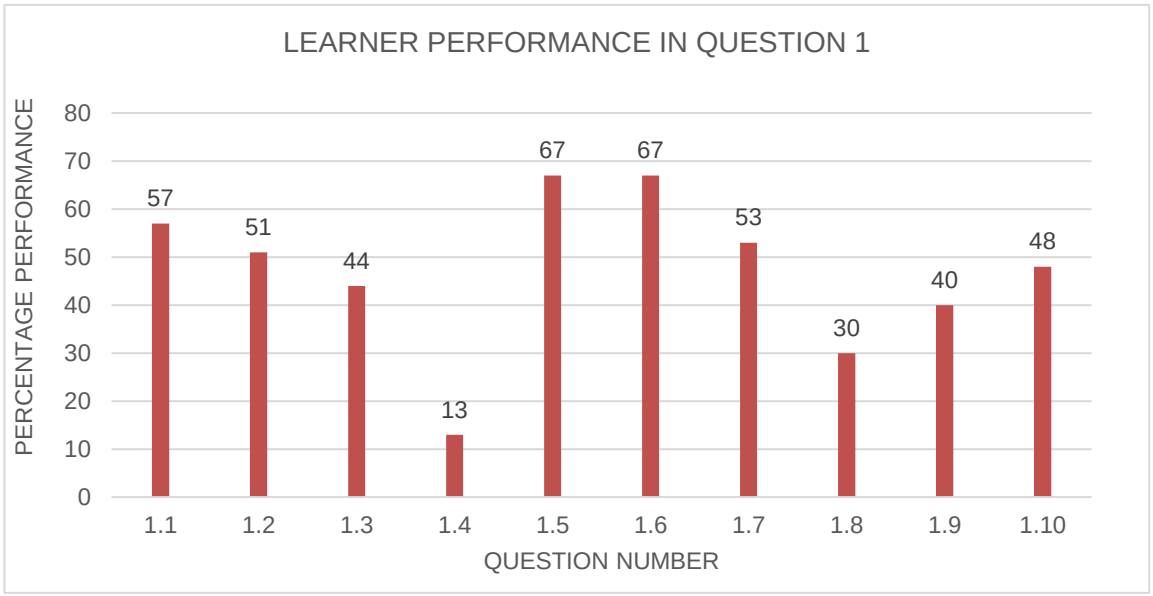
Question 1 was very poorly answered. The overall performance in question 1 was 41% in 2022 and 47% in 2023. This is a multiple-choice question yet the second worst amongst all ten questions.

LEVELS	PERCENTAGE PERFOMANCE (%)
1.1	57%
1.2	51%
1.3	44%
1.4	13%
1.5	67%
1.6	67%
1.7	53%
1.8	30%
1.9	40%
1.10	48%

Question 1.4 is the worst performed sub-question with a performance of 13%. The poor performance of this question is shifting the difficulty level of the question is shifted from a level L3 D. Q 1.8 was poorly answered with performance of 30%. Candidates does not know the application of EMF in

electric circuits.

It the application of the *ratio and proportion,* usually not given enough attention. Q 1.7 even though fairly answered but the low performance in that question could be due to the fact that it is covered in grade 10.



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

In Q 1.1 (57%) is an application of Newton's second law.

In Q 1.2(67%), candidates could not derive the mathematical expression for this scenario.

For Q 1.3(44%) – the conservation of mechanical energy application. Candidates failed to understand that the magnitude of velocity(speed) of the ball at points P and R are the same, hence could not identify the greatest distance is between points Q and S and that the largest change in E_k will happen between these two points.

Conservation of mechanical energy application.

Q 1.4 was a challenging question and the worst performed MCQ at 13%. Many candidates struggled with the application of *ratio* and *proportion*.

They failed to use the equation $v_f^2 = v_i^2 + 2g\Delta y$ to calculate $v_f^2 = 2g\Delta h$ and find p using p=mv and use the ratio.

In Q 1.5 (67%) candidates did not know the effect of θ on work done. This is due to the lack of understanding of the equation $W = f\Delta x\cos\theta$.

Q 1.6 was well answered at 67% performance. Most candidates who did not answer this question correct, answered B'' wavelength is longer than the emitted wavelength".

Overemphasis on the wavelength was used to describe relative motion to frequency.

Q 1.7(53%) tested the polarization of charge that was done in Grade 10.
Q 1.8 was poorly answered with performance of 30%. Candidates does not know the application of EMF in electric circuits.
In Q 1.9(40%) candidates should have known that a DC generator use a split ring. In a DC generator the direction of induced current is constant and the magnitude of the induced current keep on changing. The induced EMF/Current fluctuate as it is produced.
In Q 1.10 (48%), candidates struggled with the interpretation of "*ratio*". The value/term used first is written as the numerator and the second value/term is the denominator.

(c) Provide suggestions for improvement in relation to Teaching and Learning
MCQ's test learners understanding of concepts, principles, laws, and the relationships between variables. This should be demonstrated through logical reasoning and not engaging lengthy calculations. During teaching and learning, carefully selected concrete examples must be worked out to guide learner's step-by -step by demonstrating these concepts, laws and principles, followed by generalisations and making predictions. Answering MCQ's is a skill that need to be developed. MCQs should be used as part of the introduction to ALL the topics where understanding is used to teach before going into applications and also to re-enforced content at the end of the topic. Learners must be taught the importance of drawing free-force diagrams for objects and their usefulness in different problem solving must be emphasized. They must not only draw free-body diagrams when ask in a question. The conservation of mechanical energy and its application across Physical Sciences should be incorporated into each topic where applicable. Mathematical relationships and graphs should be included into teaching where learners work with ratios and proportions. Educators should clearly demonstrate the equation $W = f\Delta x\cos\theta$ and the effect that each variable should have on work done. All Electrostatics theory from Grade 10-11 need to be revised. Include PHET simulations or basic balloon experiment to demonstrate it. Teachers should use PHET simulations to demonstrate electric circuits. They should demonstrate the differences between V_{ext}, V_{int} and EMF. Teachers should use ICT, You-tube to assist in teaching of the graphical analysis of the induced EMF/ I to show the changes of EMF and I that is induced.

Educators should include more mathematical operators in teaching and activities.
Assessment of MCQs should be included in ALL class activities and not only in tests and examinations.

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

Subject advisor and lead teachers can compile MCQs booklet per topic and distribute to all educators. The skill of answering MCQs must be developed. MCQs must be used in teaching and worked into all topics and activities should be given.

QUESTION 2

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

The performance in this question was fair at 67%. The best answered amongst all the questions. Sub-question 2.1 was fairly answered at 83%.

Sub-question 2.2 was the best answered sub-question at 88%.

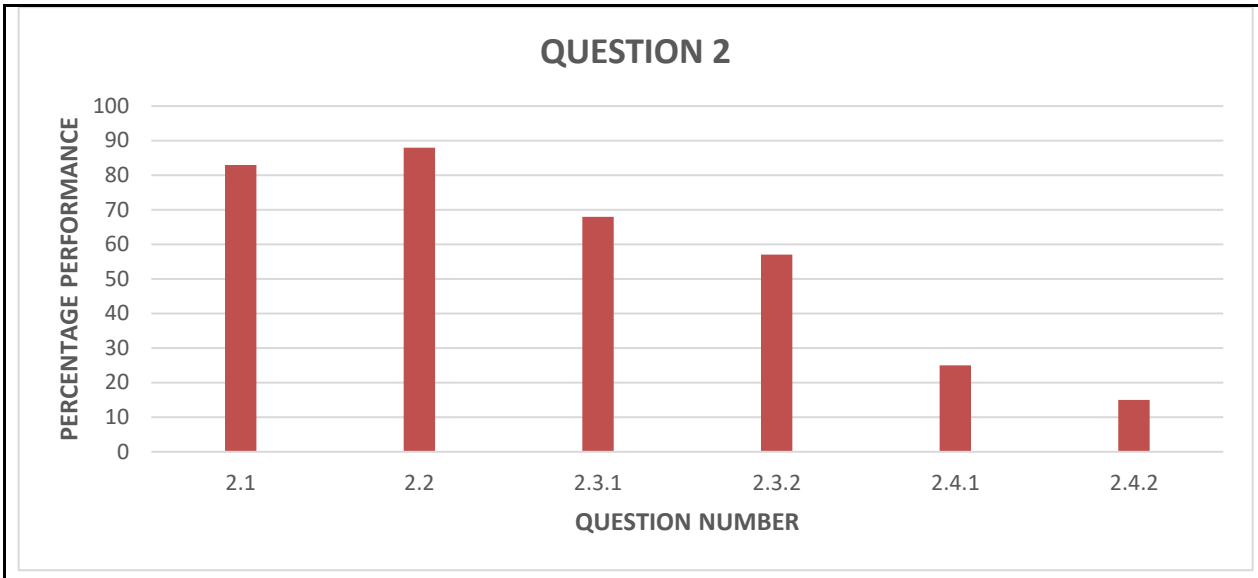
Sub-question 2.3.1 was fairly answered at 68%.

Sub-question 2.3.2 was fairly answered at 57%.

Sub-question 2.4.1 was poorly answered at 25%.

Sub-question 2.4.2 was poorly answered at 15%.

QUESTION NUMBER	% PERFORMANCE
2.1	83%
2.2	88%
2.3.1	68%
2.3.2	57%
2.4.1	25%
2.42	15%



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

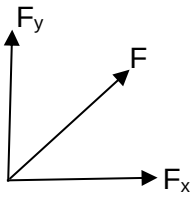
Sub-question 2.1 was fairly answered at 83%. Learners were required to state Newton's second law of motion. Some learners who lost marks were relating the net force to acceleration and mass. Example "the net force is directly proportional to the acceleration and inversely proportional to the mass". This resulted to learners losing 1 mark.

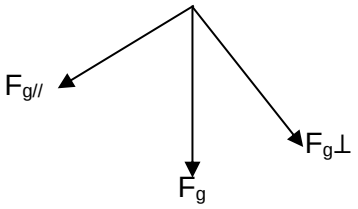
Some learners also lost 1 mark by omitting the word net.

Sub-question 2.2 was the best answered sub-question at 88%. This question required learners to draw a free-body diagram. Learners had additional force as a result they lost marks. Example some learner will draw both F_g and the components of F_g. ie $F_{g//}$ and $F\perp$. Also learners used wrong labels that are not standard symbols for labelling. Example f_r instead of F_f, f or f_k.
Some learners drew the normal force vertically upwards, they lost 1 mark for normal force.
Sub-question 2.3.1 was fairly answered at 68%. The misconceptions were about the word **constant.** Learners misinterpreted constant force as constant acceleration as a result they substituted zero for acceleration in their calculation for tension.

Learners omitted $F_{g//}$ in their calculations for Questions 2.3.1 and 2.3.2.

Some learners substituted $F_{//}$ as $F_g\cos\theta$ instead of $F_g\sin\theta$. They are confused between the components of a force that acts at an angle to the horizontal where $F_x = F\cos\theta$, $F_y = F\sin\theta$ and the components of the gravitational force. $F_{g//} = F\sin\theta$, $F_g\perp = F_g\cos\theta$. This also applies to question 2.3.2.





Some learners substituted opposite signs for the acceleration and tension whereas the two quantities are in the same direction.
Some learners were still using the system approach to calculate the ~~tension~~ **Force F** . Those who used this method could score only 1 mark.
Sub-question 2.4.1 was poorly answered at 25%. Learners were required to state the effect of decreasing the angle of an inclined surface on the kinetic frictional force. Very few learners answered this question correctly. Most learners chose the option of **remain the same.** They were relating the angle to the co-efficient of kinetic friction
The worst performed sub-question was 2.4.2 at 15%. Learners were required to explain the effect of decreasing the angle of an inclined surface on the frictional force. Direct and inverse proportions are not understood by learners. Learners could not give the relationship between kinetic frictional force and the normal force from the formula $f_k = \mu_k N$. Also understanding the trigonometry rations that as the angle increases cosine of the angle decreases. Lack of understanding and mathematical application led to learner under performance I this question

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

2.1 Learners should state definitions, laws and principles from the examination guidelines.
2.2 The correct symbols for labels should be used for all forces on the free-body diagram to avoid losing marks unnecessarily. Teach learners to draw the force instead the components of the force.
For 2.3.1 and 2.3.2, grade 11 vectors should be taught thoroughly in such a way the learners understand how the components of a vector are resolved using trigonometry ratios. Explain how the parallel component of the F_g is the opposite of the right-angle triangle and the perpendicular

component is the adjacent side of the triangle. In the case of a force inclined at an angle to the horizontal, the F parallel to the surface is the adjacent side of the triangle and the perpendicular component is the opposite side of the triangle considering the angle between the vector and the horizontal direction.

Teachers should use force diagrams to calculate forces. This will assist learners in identifying all forces that act on an object, hence learners will not omit certain forces in their calculations e.g. $F_{g//}$.

For 2.4.1 when teaching the concept of kinetic friction, practically demonstrate how the acceleration of an object increases when the angle of the inclined surface increases. If the object accelerates then it means net force increase and therefore frictional force decreases for inclined planes. Also when conducting experiment on Newton second law using the ticker timer, the runway is usually inclined to reduce the effect of friction. Teachers should explain to learners why the runway is inclined. This will assist them understand the effect of increasing or decreasing the angle of the inclined surface.

For 2.4.2, showing learners how the formulae are derived (even though not a requirement) may assist learners' understanding. The use of formulae in explanations should be encouraged to re-enforce understanding.

Example, $f_k \propto N$

Introduce a constant to change the proportional sign

$f_k = kN$, the constant is μ_k, therefore $f_k = \mu_k N$,

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

Encourage teachers to provide examination guidelines to learners.

In teaching encourage the use data sheet provided.

Teachers should use practical demonstrations to enhance understanding of a particular topic.

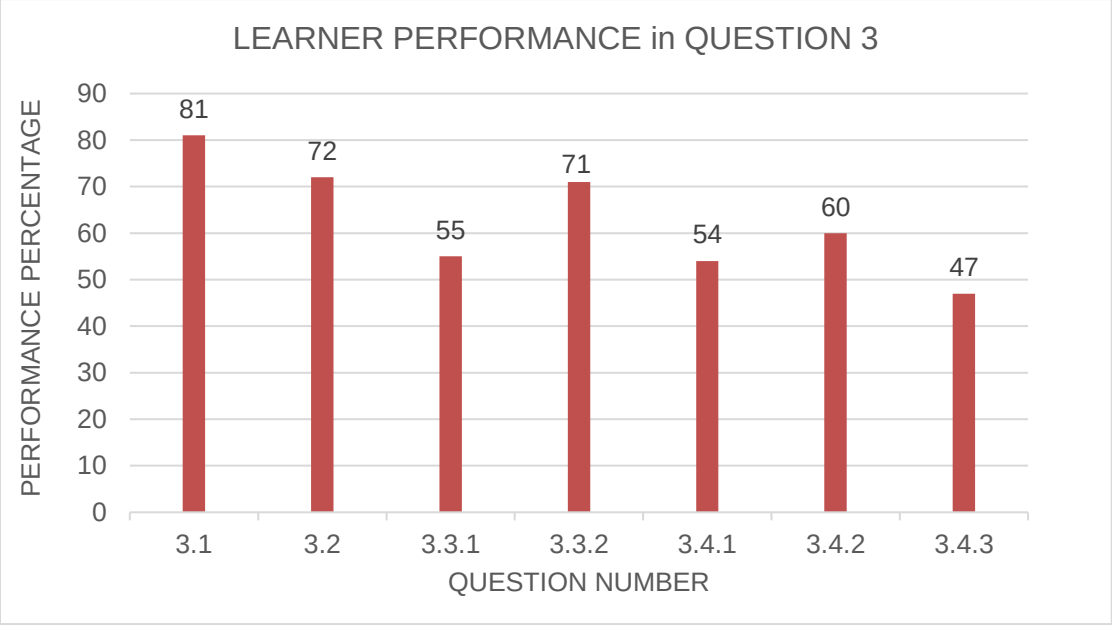
Use PHET stimulations and YouTube videos to make the concepts practicable.

QUESTION 3

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

This question was fairly answered, but dropped 68% in 2022 to 62% in 2023. Q 3.1 was the best answered sub-question at 81% in 2023 and 98% in previous year. The definition of free fall was mastered by most learners. Q3.2 with a performance of 72% was a calculation using the speed of the ball using equations of motion. The performances of Q 3.3 and Q 3.4 were respectively 55% and 54%. Q 3.3.1 was a calculation on Ek lost and Q 3.4 was testing interpretation of a given v-t graph.

LEVELS	PERCENTAGE PERFOMANCE (%)
3.1	81
3.2	72
3.3.1	55
3.3.2	71
3.4.1	54
3.4.2	60
3.4.3	47



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

Q 3.1 Candidates defined projectile motion and forfeited 2 marks. Candidates must distinguish between *projectile motion* and *free fall*. Some candidates incorrectly stated "It is the *fall* of an object under the influence of gravitational force". Some candidates omitted the word ONLY.

In Q 3.2 - 3.3, candidates used incorrect/incomplete formulae/ omitted subscripts and forfeited unnecessary marks.

Candidate are writing:

$v_f = v_i + 2a\Delta t$ instead of $v_f = a\Delta t + v_i$ OR $v_f = v_i + 2a\Delta y$ instead of $v_f^2 = v_i^2 + 2a\Delta y$ OR they omit the squares during substitution.

$F= ma$ instead of $F_{net} = ma$ OR $Ft = \Delta p$ instead of $F_{net}\Delta t = m(v_f - v_i)$. Incorrect or no units were used and the forfeited marks. Candidates substitute correctly, but calculate the answer incorrectly, due to lack of understanding the effective use of the calculator.
In Q 3.2, some candidates did not apply the correct sign convention to each vector quantity. A number of candidates failed to substitute the correct values for different stages of the motion.
Some candidates swopped the v_f and V_i.

If energy principles were used, candidates could score a maximum of 1/3 for the correct answer only.
In Q 3.3.1, the integration of projectile motion with WEP could contribute to the poor performance. Some candidates failed to understand the Ek(lost) and did not deduct Ek_f and Ek_i.

The graph was given in Q 3.4, but it was still a challenge to most learners. In Q 3.4.1 and Q 3.4.2 the performance was 54% and 60% respectively. In Q 3.4.1 candidates could not interpret the given speed of 11,92 $m.s^{-1}$ with which the ball leaves the ground and in Q 3.4.2 the speed at which the ball was projected upwards. Some candidates could not identify that K and L should have positive values as indicated on the graph. Some candidates were unable to interpret the straight line using the equation $y = mx + c$ for $v_f = a\Delta t + v_i$, where $y = v_f$, $c = vi$ and m is the gravitational acceleration. Some candidates are also giving negative values for the numerical values.

In Q 3.4.3(47%) some candidates misinterpreted the question and incorrectly calculated the values at t_2 and t_1 by subtracting it from each other instead of giving the t(ball to reach point P after leaving the ground) and forfeited the 1 mark. The question could be better rephrased as "Write down the values indicated between the interval t_1 and t_2 instead of "t_2-t_1".

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

Copies of Gr 12 Examination Guidelines 2021 should be supplied and effectively used during teaching and learning in collaboration with CAPS policies, Chief markers reports, Diagnostic reports and previous question papers. Questions should be planned according to level 1-4 and MCQs should be included in the daily activities not the end of the year only. Definitions should only be used from this EG.

Encourage learners to read a question thoroughly and write the given data.
Data sheets need to be effectively used during teaching and learning whereby educators guide learners' step-by- step in how to identify the correct formulae, do correct substitutions and how to derive to the correct answer using the calculator.

Learners must first make sure that they understand the motion of the projectile and which values are relevant at each position. A rough drawing or diagram indicating the physical motion of the projectile together with all the information given (velocities, displacements, time etc) is necessary in all scenarios.

Advise learners need to be advised to start every calculation in mechanics, including vertical projectile motion, by indicating the sign convention at the beginning of the problem. Emphasises that the direction of gravitational acceleration does not change in question, but remains constant.

Learners should be advised to keep ONE sign convention when solving a problem and not to change their chosen sign convention within the problem as this could lead to confusion.

Teach learners that time cannot be negative. They simply change it to a positive and forfeit marks for substitution.

Teach learners skills of interpreting and sketching graphs especially for projectiles. They must have a reference points and collect all relevant data before calculating any quantity.

Expose learners to several questions involving different scenarios of projectile motion.
In teaching emphasis should be put on the vector quantities such as velocity, acceleration and displacement to learners to understand that vector quantities have both magnitude and direction. When calculating such quantities, the direction should be given.

Educators should integrate topics (as when necessary) in addition to teaching each topic in isolation. Moreover, they should expose learners to problems that integrate the application of different concepts.

Encourage learners to read a question thoroughly and write the given data.

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

Supply educators with the correct CAPS policies and EG 2021. Train educators on the effective use of the CAPS policies in planning and preparation. Chief markers report and the diagnostic reports should be used effectively and in collaboration with CAPS policies. Ensure that learners are provided with EG 2021 and that definition are only used from there.

Encourage educators to use datasheets effectively in teaching and learning and guide learners step-by-step in how to use it effectively.

Learners cannot round off to correctly to a minimum of 2 decimal places. Learners forfeited

marks due to the use of correct use of calculators.
Incorrect substitutions that lead to square root of negative answers and negative time.
Magnitude is always a positive answer.
Energy need to be thoroughly taught in grade 10 and revised in Gr 12 since it is not covered in Gr 11.
Educators should use graphical analysis to track the motion of the ball/object and not simply draw graphs and then teach from it.

Integration of topics i.e WEP and projectile motion made it difficult for learners to identify formulae. Educators should integrate topics (as when necessary) in addition to teaching each topic in isolation. Moreover, they should expose learners to problems that integrate the application of different concepts. SA should assist in the mediation of reports and compiling questions on integration of topics.

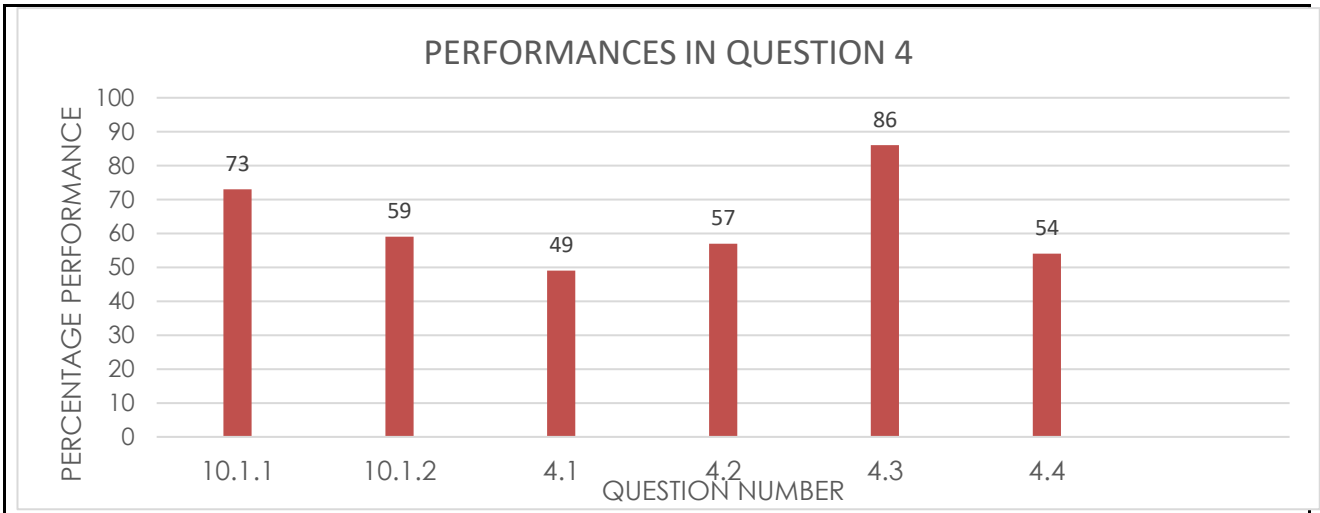
The drawing of graphs under vertical projectile motion should be given attention. The position – time, velocity – time and acceleration – time graphs should be emphasised. Both the drawing of the graph and the interpretation of the graphs should be given attention.

QUESTION 4

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

This question was fairly answered at 60 which had a slight decline of 2% from 2022.
The performance in Q 4.3 stating the principle of conservation of linear momentum was well answered by most learners at 86%. The worst sub-question is 4.1(49%) which was to write down the magnitude and direction of the average net force that bullet exerts on the trolley, followed by Q 4.1 and Q 4.5 with performances of 49% and 54 % respectively.

LEVELS	PERCENTAGE PERFOMANCE (%)
4.1	49%
4.2	57%
4.3	86%
4.4	54%



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

The poor performance in 4.1 was due to the fact that many candidates failed to relate to Newton III and wrote the magnitude with no direction or incorrect direction. Force diagrams are needed to assist wit sign convention.

In applying $F_{net}\Delta t = m(v_f - v_i)$ in Q 4.2 and Q 4.4, many candidates swopped the v_i and v_f of the bullet or used the incorrect sign convention. The omission of subscripts was observed.

Some candidates could not write the correct formulae.

They wrote: $F\Delta t = m(v_f - v_i)$ instead of $F_{net}\Delta t = m(v_f - v_i)$ OR $F_{net} = \Delta p$

$\Delta p(bullet) = \Delta p(trolley)$ instead of $\Delta p(bullet) = -\Delta p(trolley)$, Σ before = Σ after

OR omitting the – sign.

$p_i = p_f$ instead of $\Sigma p_i = \Sigma p_f$, omitting the sum(Σ) OR Σ before = Σ after

$mv + mv = mv + mv$

Some candidates do not write the formulae at all and forfeited marks.

Candidates in Q 4.2 failed to understand that F_{net} is in opposite direction of v.

Some calculated the v(trolley) instead of v(bullet). They swopped the masses and the directions.

In Q 4.3, candidates lost marks due to the omission of the words total/or isolated system. Some wrote closed system instead of isolated system.

Note that the term isolated system and not closed system.

In Q 4.4, many candidates assumed the bullet is moving at the same velocity as the trolley (relative to the ground) as used the v(bullet) as 0 $m.s^{-1}$

Candidates did not understand whether to calculate the v_f or vi. They left the answer as negative. Incorrect units are still a challenge.

Some candidates calculated v_f in Q 4.2 and only wrote the answer for Q 4.4.

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

Copies of Gr 12 Examination Guidelines 2021 should be supplied and effectively used during teaching and learning in collaboration with CAPS policies, Chief markers reports, Diagnostic reports and previous question papers. Questions should be planned according to level 1-4 and MCQs should be included in the daily activities not the end of the year only.
Definitions should only be used from this EG.

Data sheets need to be effectively used during teaching and learning whereby educators guide learners' step-by- step in how to identify and write down the correct formulae, do correct substitutions into the formula and how to derive to the correct answer using the calculator. Drill the correct units.
Encourage learners to do rough drawing or diagram indicating the physical motion to assist in the sign conventions. Learners should be advised to keep ONE sign convention when solving a problem and not to change their chosen sign convention within the problem as this could lead to confusion.
Expose learners to several questions involving different scenarios.
In teaching emphasis should be put on the vector quantities such as velocity, acceleration and displacement to learners to understand that vector quantities have both magnitude and direction. When calculating such quantities, the direction should be given.
NOTE that F_{net} is always in opposite direction of velocity.

Teach learners that time cannot be negative. They simply change it to a positive and forfeit marks for substitution.

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

In calculations involving conservation of linear momentum, the v_f and v_i should not be swopped around when substituting into the formula $F_{net}\Delta t = mv_f - mv_i$.
Copies of Gr 12 Examination Guidelines 2021 should be supplied and effectively used during teaching and learning in collaboration with CAPS policies, Chief markers reports, Diagnostic reports and previous question papers. Questions should be planned according to level 1-4 and MCQs should be included in the daily activities not the end of the year only.
Definitions should only be used from this EG.
Data sheets need to be effectively used during teaching and learning whereby educators

guide learners' step-by- step in how to identify and write down the correct formulae, do correct substitutions into the formula and how to derive to the correct answer using the calculator. Drill the correct units.

The use of calculators, rounding off to a minimum of TWO decimal places and correct numerical value and unit needs to be addressed in class while activities are done.

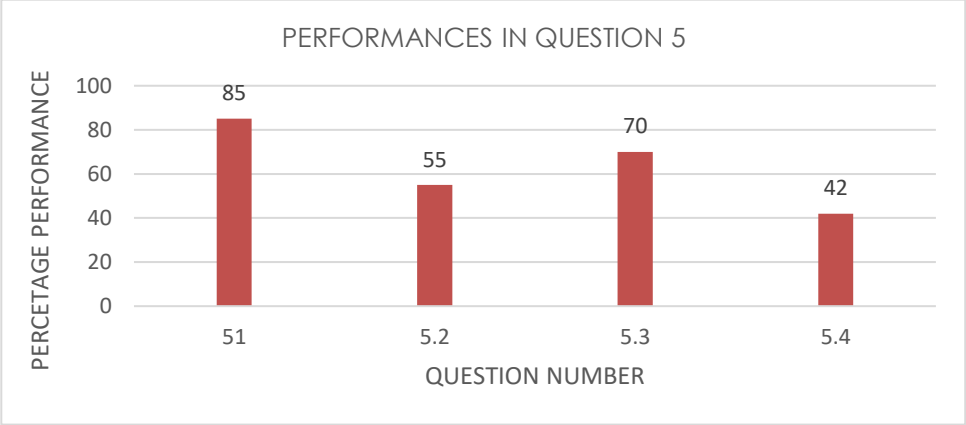
Use You-tube videos to assist learners in answering of questions step by step.

QUESTION 5

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

This question was poorly answered by learners at 58%, similar to 2022. Sub question 5.2 and Q 5.4 contributed to the poor performance of learners in this question at 55% and 42% respectively.

LEVELS	PERCENTAGE PERFOMANCE (%)
5.1	85%
5.2	55%
5.3	70%
5.4	42%



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

In Q 5 an arrow could use to indicate the direction of motion of the trolley to make the paper more user friendly. The question demanded a lot of ready and understanding.

In Q 5.1 candidates had to draw the labelled free-body diagram.
A few candidates are still drawing force diagrams. Instead of free-body diagram.
Candidates lost unnecessary marks by writing incorrect labels Frf, Ffr, *Fr, Fapp* for frictional force and *gravity* for gravitational force. Many candidates are omitting arrows and labels and draw forces that were not in contact with the dot and they could score max 2/3. Additional forces were drawn as F_{app} and candidates could score a max of 2/3.

In Q 5.2(55%), some candidates could not give the correct independent variable and candidates only wrote E_k instead of E_k initial and others wrote *distance*.

The candidates were required to state the work-energy theorem in Q 5.3(70%). Most omitted the *net/total* and others omitted *change*. A few wrote "*rate of change* in Ek".
A few wrote "kinetic friction" instead of "kinetic energy".

Q 5.4 was the worst answered sub-question with a performance of 42%. Candidates had to interpret the graph and understand what the experiment was about.
They need to note that *Eki was applied* to the trolley and it came *to rest*. Experiments was repeated with different Eki. Results obtained was use to draw the graph.
The negative sign for W(-W) is not the direction, but rather indicating that energy is either removed or added lost by that particular force.
Candidates that used the gradient in the calculation, could not relate their calculation to frictional force and forfeited a mark. They calculate the gradient and continue to substitute into

fk = μN without writing the gradient = $\frac{\Delta y}{\Delta x} = \frac{1}{f}$.

Most candidates did not know that in lost Energy carries a negative sign. Hence, they swopped coordinates of ΔEki e.g 12-6, instead of 6-12; 6-0, instead of 0-6 and was use to compensate for -mass(-m).
The distance is in the positive direction. In W = fΔx cos θ, θ represents the angle between F and Δx.
Incorrect trigonometric substitution for θ as cos 0 instead of cos 180 were observed in a few cases.
The omission of subscripts in $W_{net}/W_{nc}/W_f/ F_{net}/ Ek_f/Ek_i$ OR omission Δ in ΔEk/ΔU.
Candidate forfeited marks due to the use of calculator and others incorrect substitution of incorrect values for two co-ordinates from the graph.

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

In Q 5.1 it is very important to note that in free-body diagrams, the forces always move/flow out of the dot. The importance of drawing free-body diagrams for an object correctly and the usefulness in problem solving must be emphasised. Encourage learners to use different problem-solving strategies to solve the same problem to ensure they gain a greater understanding of their problem and their solutions in Q 5.1. The mark allocation should be used as a guide to indicate the number of forces for the free-body diagram.

In Q 5.2 learners must be taught graphical analysis. The independent variable is indicated by the X-axis and the dependent variable by the y-axis.

In Q 5.3 copies of Gr 12 Examination Guidelines 2021 should be supplied to learners and effectively used during teaching and learning. Definitions should only be used from this instrument. Definitions can be done for homework and tested in class next day. Use Chief markers and Diagnostic reports in planning and this can assist in eliminating the errors.

In Q 5.4 learners must use force diagrams to assist in identifying the direction of forces.
Teachers must emphasise that the "lost" in energy is negative and that work done by a frictional force is *negative work done*.
The equation, $\mathbf{W = f\Delta x \cos \theta}$ represents work done by a particular force, where f is substituted as a positive value and θ is the angle between f and Δx.
For equation $\mathbf{W_{net} = \Delta E_k}$, $W_{net} = W_f$ that implies work done is negative and therefore ΔE_k must be negative.
Learners need to be systematically exposed to different questions in which trigonometric relations must be applied.
Use PHET simulations for the identification of forces.

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

The free-body diagram for Q 5.2 was well answered as it is a skill developed from grade 11 and constantly tested.
Development are seriously needed for WEP.
Teachers must emphasise that the "lost" in energy is negative and that work done by a frictional force is *negative work done*.
The equation, $\mathbf{W = f\Delta x \cos \theta}$ represents work done by a particular force, where f is substituted as a positive value and θ is the angle between f and Δx.
For equation $\mathbf{W_{net} = \Delta E_k}$, $W_{net} = W_f$ that implies work done is negative and therefore ΔE_k must be

negative.

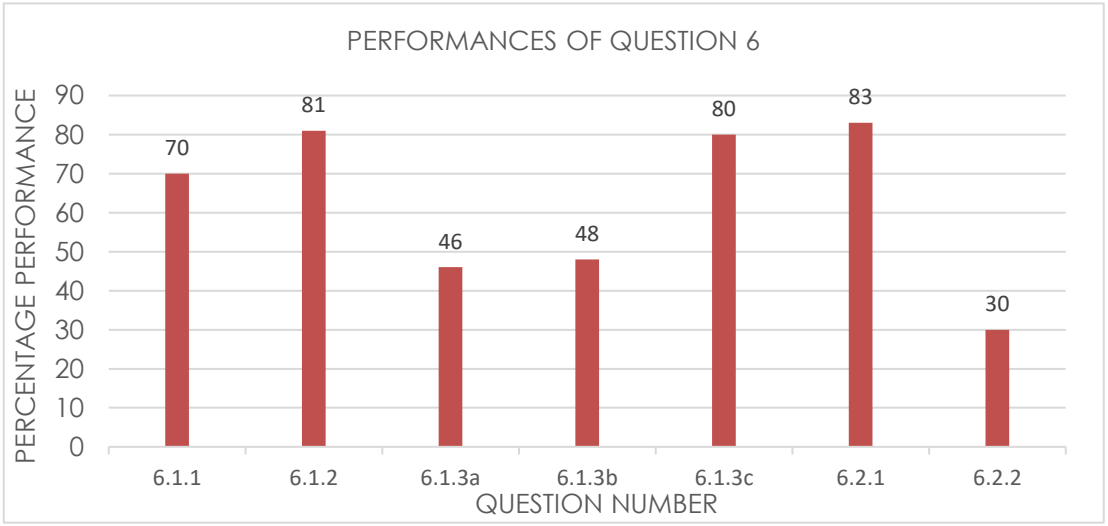
Questions on topic need to be compiled and graphs need to be included.

QUESTION 6

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

This question performance is improved from 62% in 2022 to 66%. Q 6.2.1 was the best answered sub-question at 83% and the worst sub question was 6.2.2 at 30%.

LEVELS	PERCENTAGE PERFOMANCE (%)
6.1.1	70%
6.1.2	81%
6.1.3 a	46%
6.1.3 b	48%
6.1.3 c	80%
6.2.1	83%
6.2.2	30%



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

In Q 6.1.1 the "*change*" and" *relative motion*" were omitted in the Doppler effect.

Many candidates still use the incorrect formula $f_L = \frac{v+vL}{v+vs} f_s$ OR $f_L = \frac{v-vL}{v-vs} f_s$ in Q 6.1.2.

Learners swopped f_L and f_s in their substitutions, e.g many uses fL = 550Hz and fs =512,64 Hz instead of f_L = 512,64 Hz and f_s = 550 Hz.

Those who substituted correctly, struggled with the mathematics to arrive at the correct answer.

In Q 6.1.3a (46%) many of the candidates do not know the factors that influence the speed of sound e.g temperature. It remains constant under certain conditions.

In Q 6.1.3b (48%), there are misconception between the perceived frequency and the actual frequency. Many candidates incorrectly choose increases.

In Q 6.1.3c and Q 6.2.1 were well answered with performance of 80% and 83% respectively.

Q 6.2.2 was poorly answered at 30%. Most candidates could not express themselves in this question. They could only relate the movement to frequency and wavelength.

Learners could not relate the *perceive* colour to the frequency/ or to the shift observed in the spectrum. They repeated the "red shifted" as in given question.

Reason could be that underteaching were taken place in this sub-topic.

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

Q 6.1.1 Encourage learners to use the Doppler Effect formula as it appears on the datasheet. Copies of Gr 12 Examination Guidelines 2021 should be supplied to learners and effectively used during teaching and learning. Definitions should only be used from this instrument. Use EAC (interpret the definition in order for learners to understand and be able to apply. Definitions can be done for homework and tested in class next day. Use Chief markers and Diagnostic reports in planning and this can assist in eliminating the errors.

In Q 6.1.2 encourage learners to the equation $f_L = \frac{v \pm vL}{v \pm vs} f_s$ as it appears on the datasheet provided. They must always keep the plus and minus there in the first step of writing the formula. Only once substitution starts, should they change the signs.

Learners need to be given their own copy of the datasheet and it should be used effectively as a resource in teaching and learning. Teachers must reinforce the perceived frequency against the actual frequency. Learner must know the effect of relative motion on the perceived frequency/wavelength against the actual frequency.

Q 6.2.2 teachers must clearly explain why the spectral lines shifted towards the red end of the spectrum. This shifting towards the red end of the spectrum indicated lower frequency and lower frequency indicates longer wavelength according to c = fλ.

Educators need to expose learners to a variety of questions relating to the Doppler effect as the scope is very broad, given the number of variables in the equation.

Use PHET simulations, YouTube videos and the *Ten-Fold app to demonstrate the Doppler effect.*

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

Training on the effective use of PHET simulations. The perceived frequency against the actual frequency need to be reinforced. Learner must know the effect of relative motion on the

perceived frequency/wavelength against the actual frequency.

According to Page 11 of EG:

With light -red shift in the universe: Explain red shifts need to be taught in depth.

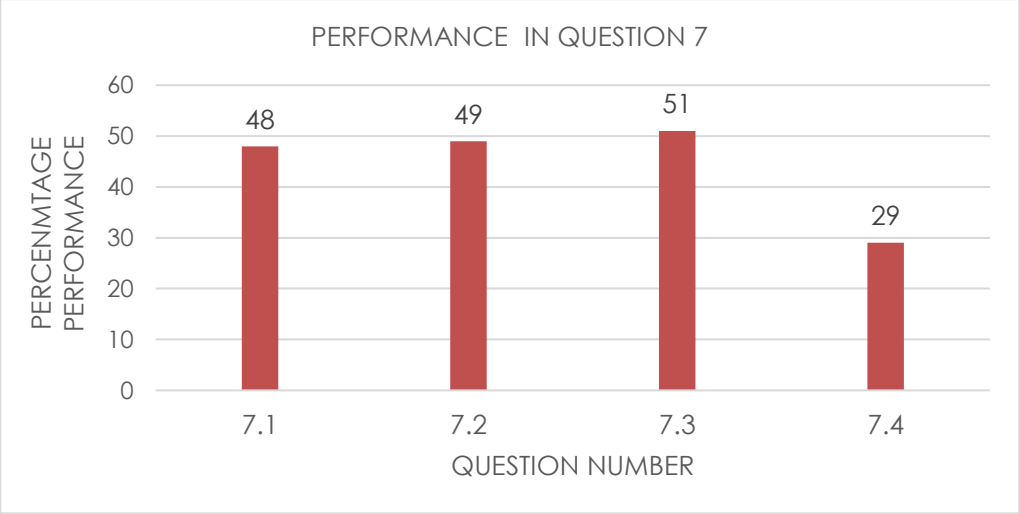
Teachers must clearly explain why the spectral lines shifted towards the red end of the spectrum. This shifting towards the red end of the spectrum indicated lower frequency and lower frequency indicates longer wavelength according to $c = f\lambda$.

QUESTION 7

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

This question was poorly answered by most learners at 45%. The worst sub question is Q 7.4 at 27% where candidates were expected to calculate magnitude of the net electrostatic force on an electron would experience if placed at point P.

LEVELS	PERCENTAGE PERFOMANCE (%)
7.1	48%
7.2	49%
7.3	51%
7.4	29%



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

Q 7.1(48%) were poorly answered. Candidates omitted either "charge" or "field". Some defined an electric field at a point and scored 0/2.

Q7.2(49%), were poorly answered. Many candidates could not draw the electric fields pattern correctly. The forfeited marks for the shape and field lines crossing each other/not touching the

charge/not going inside the charge. Some candidates draw patterns of two opposite charges and scored a max of 0/2. The MG allowed to draw one single charge and candidates could score 1/3 if the direction was correct.

Candidates substituted negative sign for charges

In Q 7.3(51%). In the equation $E = \frac{kQ}{r2}$, candidates are using k = $9x10^{-9}$ instead of k = $9x10^{9}$.

Some wrote $E = \frac{kQ}{r}$ OR $E = \frac{kQ}{2r}$ and also omitted the square in the substitution.

Others wrote $E = \frac{kQ1Q2}{r2}$.

Many candidates are using *3r* instead of *r*, where they added the distances and the did not square the r in the formula. They also substituted E_A= 27 or E_B= 27 instead of the E_{net} = 27.

Some wrote: $E_{net}^2 = E_A^2 + E_B^2$.

Candidates could not identify the field at a point for A is to the right and B is to the left. Hence, E_{net} is the difference between E_A and E_B. Others struggled with the mathematics to solve for *r, similar errors as in Q 6.1.3.* Candidates did not know the effect of *r* on *E* and hence, E_{net} is to the right therefore E_{net} and E_A is in the same direction.

Q 7.4 (29%) the worst performed question. Some candidate wrote $F = \frac{kQ}{r2}$ instead of $E = \frac{kQ}{r2}$.

Some candidates substituted negative values for Q_e ($1,6x10^{-19}$) into $F = \frac{kQ1Q2}{r2}$.

The equations $\mathbf{E = \frac{kQ}{r2}}$ and $\mathbf{E = \frac{F}{q}}$ refer to the field at a point where Q is responsible for the field.

Educators need to clearly differentiate between $\mathbf{E = \frac{kQ}{r2}}$ and $\mathbf{E = \frac{F}{q}}$

Force in an electric field either be represented by $\mathbf{F= \frac{kQ1Q2}{r2}}$ or **F = qE**.

There are two charges that are responsible for the force at a point P. Hence there must be two forces and a resultant between the two.

The resultant for it is related to the resultant electric field at a point.

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

Q 7.1 Copies of Gr 12 Examination Guidelines 2021 should be supplied to learners and effectively used during teaching and learning. Definitions should only be used from this instrument. Use EAC (interpret the definition in order for learners to understand and be able to apply.

Definitions can be done for homework and tested in class next day. Use Chief markers and Diagnostic reports in planning and this can assist in eliminating the errors.

In Q 7.2 the concept of drawing field lines should be effectively done in grade 9. Where

learners have the opportunity to play with the magnets and iron filings.
Educators need to revise electric field patterns in grade 12 and stress the properties of field lines. The use of a ruler where necessary for the shape and colour the sphere to eliminate the loss of marks for field lines crossing each other/not touching the charge/not going inside the charge.
This is very important in doing the calculations (Level 3) questions. Use PHET simulations, YouTube to demonstrate the field patterns around different charges.

In Q 7.3 educators need to use sign conventions to use force diagrams to assist learners with the sign conventions where working with forces.

Q 7.4 The equations $\mathbf{E = \frac{kQ}{r2}}$ and $\mathbf{E = \frac{F}{q}}$ refer to the field at a point where Q is responsible for the field.

Educators need to clearly differentiate between $\mathbf{E = \frac{kQ}{r2}}$ and $\mathbf{E = \frac{F}{q}}$.

Force in an electric field either be represented by $\mathbf{F = \frac{kQ1Q2}{r2}}$ or **F = qE**.

There are two charges that are responsible for the force at a point P. Hence there must be two forces and a resultant/between the two.
The resultant for it is related to the resultant electric field at a point.

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

Maybe curriculum planners should include electrostatics in control test in term 1 as well as June common assessment since this concept is taught in grade 11 most learners turn to give little attention to it in terms of revision.
In-depth training is required in electrostatics.
Some learners substituted the negative charge into F= $\frac{kQ1Q2}{r2}$ and F = qE. This results in the learners getting the directions of the force in Q 7.4 wrong.
When using the above formula only the magnitude of the charge should be substituted.

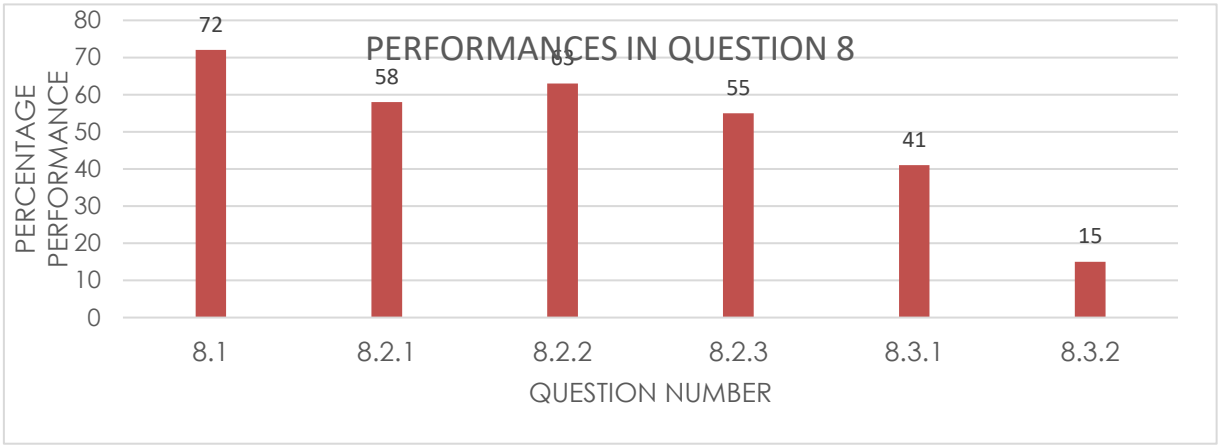
QUESTION 8

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

Q 8.1 poorly answered question at 51%. Electric circuits is generally challenging to leaners. Q 8.3.2 is the worst performed sub question at 15%.

LEVELS	PERCENTAGE PERFOMANCE (%)
8.1	72%
8.2.1	58%
8.2.2	63%
8.2.3	55%

8.3.1	41%
8.3.2	15%



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

Q 8.1 Fairly answered at 72%. Most learners scored full marks. A few omitted constant temperatures OR "the resistance is directly proportional to the potential difference and inversely proportional to the current" OR "potential difference is equal to the current".
Some were using the formula R = V/I to define Ohm's Law by changing the subject of the formula to I = V/R. The current is directly proportional to potential difference and inversely proportional to the resistance.
Indirectly proportional instead of inversely proportional was frequently used by learners.
Q8.2.1 The common error was in the formula for parallel resistors.

R = $\frac{1}{R1} + \frac{1}{R2}$ instead of $\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} = \frac{1}{10} + \frac{1}{10}$ Rp = 5Ω

OR

$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} = \frac{1}{10} + \frac{1}{10} + \frac{1}{10}$

OR

$R_p = \left(\frac{R1x\ R2}{R1+\ R2}\right)^{-1}$ instead of $R_p = \left(\frac{R1x\ R2}{R1+\ R2}\right)$

Candidates could not identify the resistors that the two resistors (R1 and R2) are first in parallel and then in series to the light bulb(R2).
Candidates omitted the formula for parallel resistors and forfeited 1 mark.
Candidates did not inverse 1/R = 0,2 to obtain R_p =5Ω

Q 8.2.2 Some candidates use the equation $\mathcal{E}$ = I (R+r) when calculating the total resistance.
(the equation adds two unknowns)
Some were using the formula R = V/I and omitted add the internal resistance to the calculated total external R in Question 8.2.1

Hence, candidates who used the equation, R = V/I instead of EMF = I (R+ r) forfeited 2 marks since R = V/I does not specify which resistance.

Q 8.2.3 Candidates who used the equation P = I^2R struggled find the current that passes through Resistor R3 and forfeited 2 marks.

Candidates who used the equation P = $\frac{V2}{R}$ could not find the potential difference across resistor R_3.

Some candidate incorrectly wrote P = $\frac{V}{R}$ instead of P = $\frac{V2}{R}$ and forfeited 2 marks.

Candidates who used the formula P =VI only obtained the mark for the formula as they could not find the potential difference and the current of the resistor R_3

In Q 8.3.1, most candidates wrote decreases.

Q 8.3.2 This was a higher order question.

Learners struggle to identify that the total resistance of the circuit increases and hence the total current decreases.

Candidates could not use the formula EMF = V_{ext} - Ir to express themselves.

Most candidates omitted the word "total".

Candidates confused the total I that decreased vs the original current that went through the light bulb.

Candidates could not relate the brightness of the light bulb to the power output.

It was observed that the concept of Power in electrical circuits was not taught thoroughly.

Candidates could not relate to brightness of the light bulb to the power output.

It was observed that consent of Power in electrical circuits was not taught thoroughly.

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

Educators must use EG 2021 for definitions and datasheets in teaching and learning.

Candidates are still writing equations incorrectly.

Educators must do enrichment and revise the basic concepts of electric circuits before proceeding to internal resistance in Gr 12.

Educators should use ICT visuals e.g., PHET simulations when teaching electric circuits. This will assist candidates to visualise and understand electric circuits better.

Teachers must cover power properly in electric circuit and its different formula.

Use past question papers of different scenarios to expose learners to these types of questions.

Learners should be made to under that the R_1 & R_2 in the parallel resistors' formula are not necessarily individual resistance but resistance in the branch. In a branch in the circuit there could be more than one resistor but all the resistance in that branch is equivalent to R_1.

Development or/and Subject Advisors must train educators in the usage of ICT in their classrooms especially when it comes to electric circuits.

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

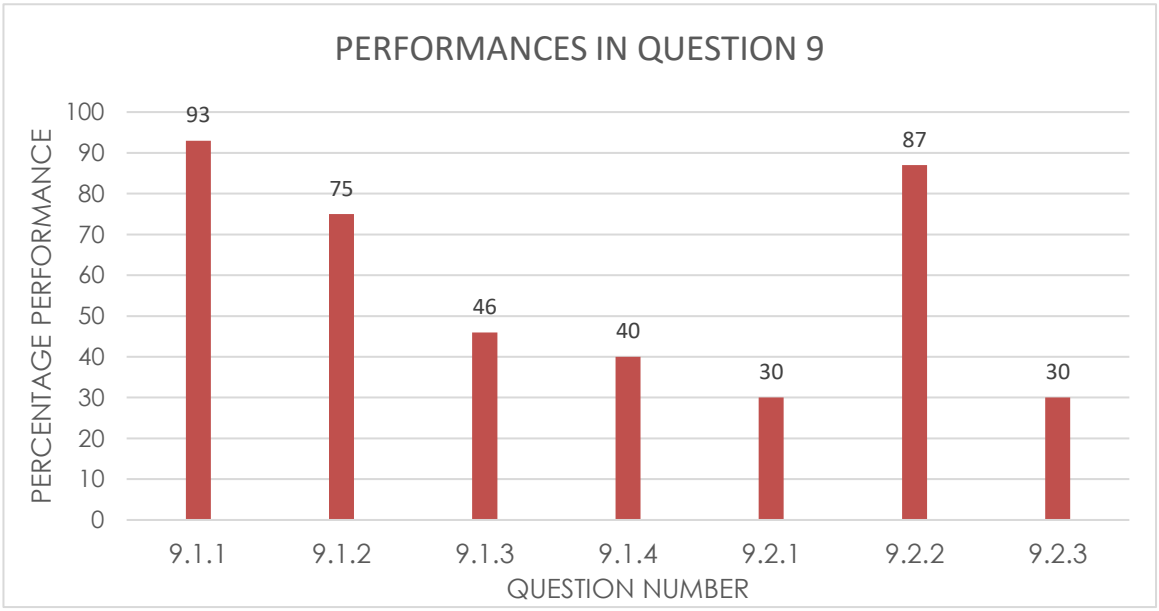
In 8.5 learners were required to explain the effect of having a high resistance voltmeter in one of the parallel branches. This was decimally answered. Teachers in teaching should take into consideration the different changes that can occur in the circuit and the effect of the change to the total resistance, current, lost volt, external voltage and the power dissipated by the battery or any resistor in the circuit.

QUESTION 9

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

The overall performance in this question was fair at 59%. The best performed questions were Q9.1.1 and Q 9.2.2 at 93% and 87 % respectively.

LEVELS	PERCENTAGE PERFOMANCE (%)
9.1.1	93%
9.1.2	75%
9.1.3	46%
9.1.4	40%
9.2.1	30%
9.2.2	87%
9.2.3	54%



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

In Q 9.1.1(93%) was well answered. A few candidates wrote "slit rings" or "slip" only.

In Q 9.1.2(75%) was well answered and candidate responses were: "electrical to chemical"/ "mechanical to chemical" / "chemical to mechanical". They mixed the energy conversions with electrochemical cells.

In Q 9.1.3 (46%) the performance was poor and most candidates selected anti-clockwise.

In Q 9.1.4(40%) the performances were poor. Many candidates had difficulty in defining the tern root mean square current. The candidate's common errors were: larger magnets instead of stronger magnets/ increase number of cells or stronger battery or increase in power source instead of increase number of cells in series/increase in EMF. Cells in parallel keeps the potential difference the same/ increase in the speed of the coil (this was in the question)

In Q 9.2.1(30%) most candidates omitted "equivalent" or "energy" or "heat". Candidates wrote "DC potential difference" instead of "direct current (DC)" If energy" or "heat" was omitted candidates scored 0/2

Q 9.2.2(87%) was well answered. Some candidates used $V_{rms} = \frac{vmax}{\sqrt{2}}$ instead of $I_{rms} = \frac{Imax}{\sqrt{2}}$.

Candidates substituted into I_{rms} instead of I_{max}. Candidate forfeited the final mark for incorrect rounding and no or incorrect unit.

Q 9.2.3(54%) was poorly answered. No conversion of time from minutes to seconds. Candidates calculated power, instead of energy. A few wrote watt(W) instead of joules(J) as the unit for energy. 220V was substituted as Vmax instead of V_{rms}.

Some candidates still omitted subscripts "rms" and "max" in the equations $P_{ave} = V_{rms} I_{rms}$, Pave = $I^2_{rms} R$ and $P_{ave} = V^2_{rms}/R$.

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

Teachers should train learners to read questions carefully and analyse the information that is required before answering the questions.

Q 9.1.1 The components to motors/generators must be clearly covered during teaching.

Q 9.1.2 Teachers need to relate the application of motor to a fan/washing machine so learners can clearly identify energy conversions.

Q 9.1.3 Teachers need to use Flemming's left hand rule for motors and right-hand rule for generators. Teachers need to use 3-D objects in exploring Flemming's left- and right-hand rule. Use PHET simulations and YouTube to reinforce it.

Q 9.1.4 Built simple motors and demonstrate what physical changes can be made to the motor to rotate the coil faster. Use ICT to demonstrate how a motor works and the physical changes that can be made to increase the speed of the rotation of the coil.

Q 9.2.1 Educators must use and explain the definitions from the EG 2021 so that learners can

understand the key words in a particular definition.

Q 9.2.2 Educators need to use basic calculations(L3) to re- inforce rounding and use of correct units.

Q 9.2.3 Educators need to clearly demonstrate the difference between power and energy during teaching and use the datasheets to assist with identifying the correct formulae. Some candidates still omitted subscripts" rms" and "max" in the equations $P_{ave} = V_{rms} I_{rms}$, Pave = $I^2_{rms} R$ =and

$P_{ave} = V^2_{rms}/R$.

The Grade11 work on electromagnetic induction must be revised in Grade 12 when motors and generators are discussed.

Use Khan Academy, PHET and Edukite are very useful resources for educators.

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

Subject advisors must mediate the Chief Markers and diagnostic report per term. Emphasis must be placed on the use of subscripts when taking formulae from datasheets for calculations. The components to motors/generators must be clearly covered during teaching.

Teachers need to relate the application of motor to a fan/washing machine so learners can clearly identify energy conversions. Teachers need to use Flemming's left hand rule for motors and right-hand rule for generators. Teachers need to use 3-D objects in exploring Flemming's left- and right-hand rule. Use PHET simulations and YouTube to reinforce it.

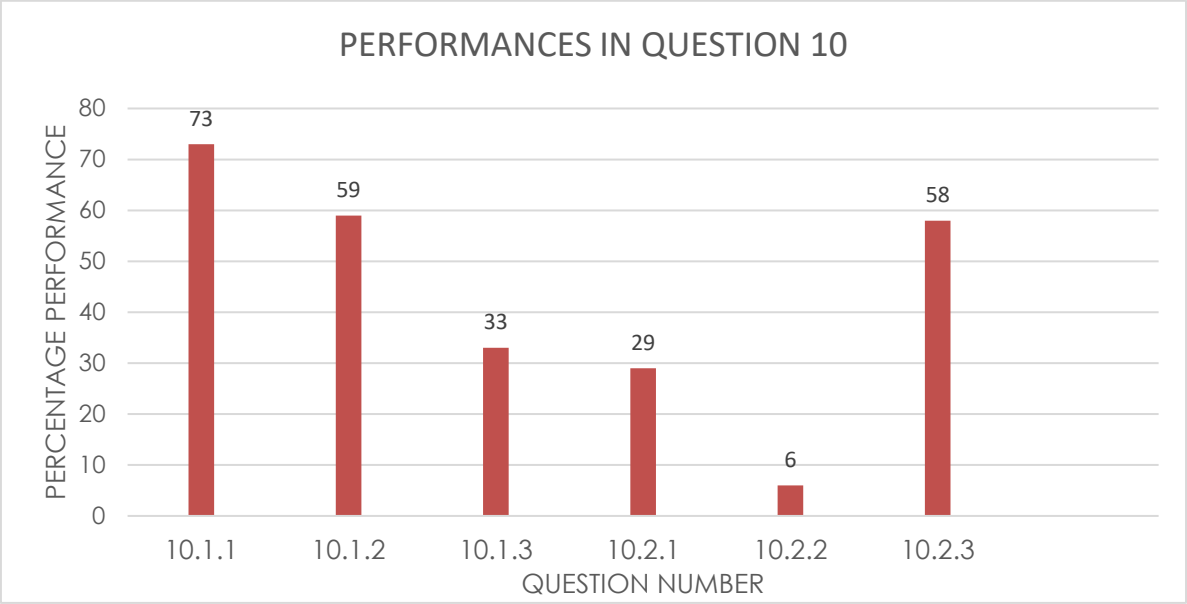
E learning must supply PHET simulations and YouTube videos on Motors and generators. Use ICT to demonstrate how a motor works and the physical changes that can be made to increase the speed of the rotation of the coil. The graphs will also be well understood.

QUESTION 10

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

This question was poorly answered at 43% compared to 46% in 2022. Q 10.2 .2 is the worst performed question at 6% that requested candidates to describe the spectrum referred to in QUESTION 10.2.1. The poor performance of Q 10.1.3(33%) is due to the integration of electrostatics and photoelectric effect.

LEVELS	PERCENTAGE PERFOMANCE (%)
10.1.1	73%
10.1.2	59%
10.1.3	33%
10.2.1	29%
10.2.2	6%
10.2.3	58%



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

In 10.1.1(73%) Some candidates defined threshold frequency instead of work function and scored 0/2. Other candidates omitted the word minimum/energy/from a metal or surface.

Q 10.1.2(59%) Most candidates could score full marks or part marks. Candidates could do the calculation, but failed to do the conclusion of E > Wo/ f > fo/ λ >λo / $Ek_{(max)}$ > o/ V_{max} > 0 for electrons to be ejected.

Some did not write the formula or omitted subscripts: Ek instead of $Ek_{(max)}$ or v instead of v_{max} or W instead of Wo.

Q 10.1.3(33%) was poorly answered question due to the integration of electrostatics and photo electric effect. This topic is done last according to ATP and it was not tested in any examination except in the Trail Examination.

Candidates could not differentiate between energy of the photon E = hf and

E for the electric field at a point $E = \frac{kQ}{r2}$ or $E = \frac{F}{q}$

They used E = hf instead of $F = \frac{k\,Q1\,Q2}{r2}$ or $E = \frac{kQ}{r2}$ and $E = \frac{F}{q}$

In the formula n = Q/e, n is a positive integer.

NOTE: If Q is positive, use e ($1{,}6 \times 10^{-19}$) and when Q is negative, use e ($-1{,}6 \times 10^{-19}$).

n(photons): n(e-) = 1: 1

Candidate forfeited the marks of n was left as a negative number for e-s.

Many left the answer without mentioning the number of photons and forfeited the marks.

Q 10.2.1(29%) Candidates failed to name the type of line spectrum. They responses were: red shift and blue shift.

Q 10.2.2(6%) Candidates failed to describe the spectrum.

Q 10.2.3(58%) Candidates could guess between Diagram A or B and either scored 2 or 0

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

Teachers need to use PHET-simulation to demonstrate the photo-electric effect as it is an abstract concept.

Teachers need to emphasize that one photon with sufficient energy will eject one electron the additional energy of the photon is then converted to maximum kinetic energy of the photo-electron.

Teachers should make learners aware that topics are not in isolation. Use pass question papers to drill learners before examination and throughout the year. More time should be given to matter and materials on the ATP.

10.2 Teachers need to identify the two different spectra.

Teachers should from the continuous colour spectrum of white light and then proceed to the line spectra.

Differentiate the process of how these spectra are obtained e.g, certain frequencies are absorbed or released and relate these frequencies to the colour that will either be displayed on the emission spectra or missing from the line absorption spectra.

Teachers need to use YouTube videos to assist in the demonstration of the two spectra.

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

This topic is done last and under teaching were observed. Topics test need to be done at the end of all topics to identify challenges and address it during intervention classes. The basics of photoelectric effect should be emphasised and integration should be practised.

SA must develop material to assist educators.