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

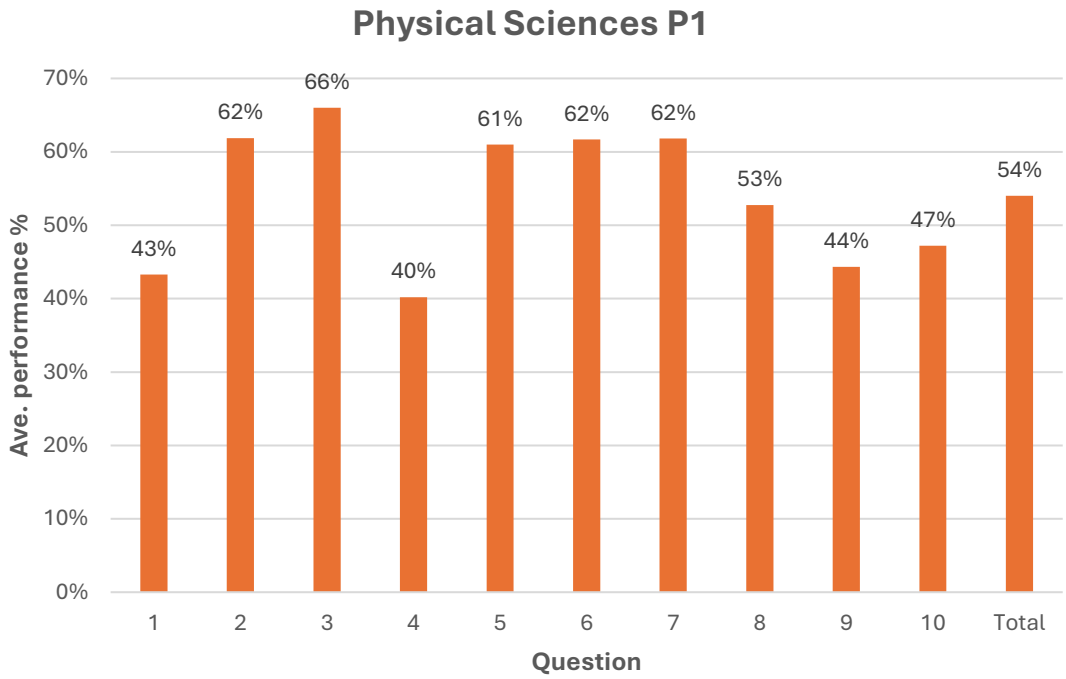
2025 NSC CHIEF MARKER'S REPORT

SUBJECT	PHYSICAL SCIENCES		
QUESTION PAPER	~~1~~	2	3
DURATION OF QUESTION PAPER	3 HOURS		
PROVINCE	**EASTERN CAPE**		
NAME OF THE INTERNAL MODERATOR	**C OWUSU ANSAH**		
NAME OF THE CHIEF MARKER	**Q PLAATJES**		
DATES OF MARKING	**02/12/2025 – 11/12/2025**		
HEAD OF EXAMINATION:	**EM MABONA**		

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

The following graph was based on a sample of 100 scripts that was randomly selected based on the 7 point scale. This graphs may not accurately described provincial performances of candidates, it does provide useful insights into the assessment of candidates on the various levels.
Question 1 (multiple-choice) which include all topics was one of the worst performing questions. Questions were pitched at level 2, 3 and 4. Candidates were not exposed to multiple-choice questions in informal assessments and hence candidates do not have the required skills to answer multiple-choice questions.
Candidates showed lack of understanding in mathematical relationships especially in the use of ratios.
Instructions and Information on page 2 of the question paper has points 7, 8, 9 and 10. These instructions give guidance to what is expected from candidates. Candidates did not show ALL their workings as required by point 7. Candidates still have issues with rounding off, instruction 8 clearly says round your FINAL NUMERICAL answer to a minimum of TWO decimal places.
Candidates do not use the data sheets in copying the correct formula as pointed out in point 10 instead they try to recall the correct formula. Candidates omit subscripts and forfeited the formula mark.
Candidates did not perform well in questions that require explanations. Candidates could not express themselves in answering explanation questions. Point 8 deals with what is expected from candidates when explaining answers.
Candidates struggled to interpret graphs in this question paper e.g Q 1.1, 1.10, Q 4, Q 6 and Q 9.4.
Candidates also struggled to draw graphs on questions 4.3 and 9.4.
Candidates struggled with static frictional force in question 2. This topic is covered in grade 11.
The direction of vector quantities was generally omitted by candidates.

The candidates did not performance well throughout the paper with question 4 being the worst performing question. Question 3 was the best performing question.



Question	Topic	Ave. performance %
1	MULTIPLE-CHOICE QUESTION	43%
2	NEWTON'S LAWS OF MOTION	62%
3	VERTICAL PROJECTILE MOTION	66%
4	MOMENTUM AND IMPULSE	40%
5	WORK, ENERGY AND POWER	61%
6	DOPPLER EFFECT	62%
7	Electrostatics (Coulomb's law and electric fields)	62%
8	ELECTRIC CIRCUITS	53%
9	ELECTRODYNAMICS	44%
10	PHOTOELECTRIC EFFECT	47%
Total		**54%**

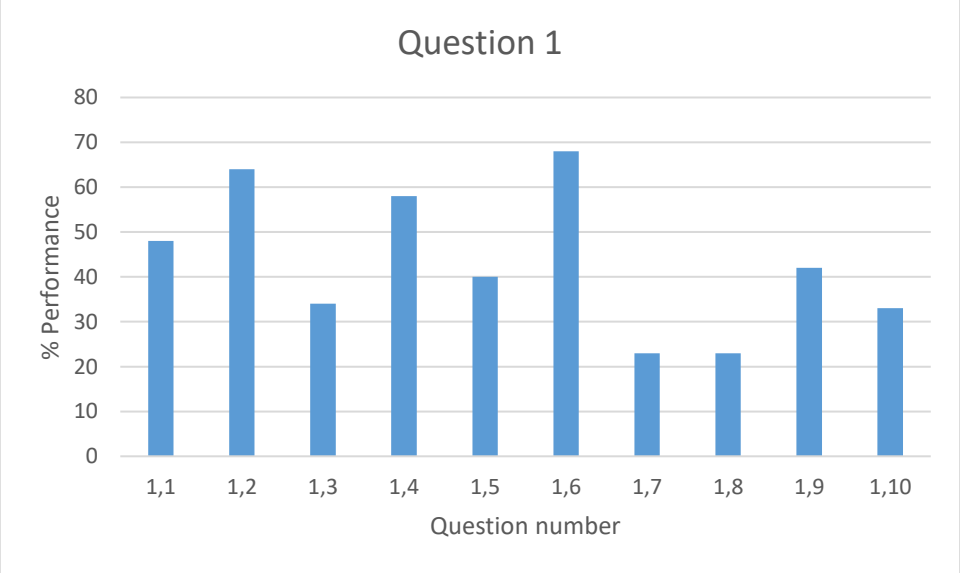
SECTION 2: Comment on candidates' performance in individual questions

QUESTION 1

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

The question was poorly answered with performance at an average of 43 %. Sub-question 1.6 was the best performing question at an average of 68 % while sub-question 1.8 was the worst performing sub-question at an average of 23 %.

QUESTION NUMBER	% PERFORMANCE
1.1	48
1.2	64
1.3	34
1.4	58
1.5	40
1.6	68
1.7	23
1.8	23
1.9	42
1.10	33



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

Q 1.1 Many candidates selected **A** as their answer. This indicates that candidates confuse motion and acceleration in Newton's second law of motion.

Q 1.2 Many candidates selected **D** as their answer. The word "*dropped*" confused candidates that the initial velocity of the stone is zero. Candidates could not apply Newton's first law to the stone as the stone would have the same initial velocity as the hot-air balloon and then treat it as a projectile.

Q 1.3 Many candidates selected **D** as their answer. Candidates could not interpret that constant velocity indicated that force applied and the gravitational force on the box are equal. Using $P_{ave} = Fv_{ave}$ showed that the power remained constant. Candidates also did not know that the system was not isolated therefore the mechanical energy would not remain constant.

Q 1.4 Many candidates selected **B** as their answer. Candidates could not apply p = mv correctly using ratios.

Q 1.5 Many candidates selected **D** as their answer. Candidates understood that a constant net external force would imply a constant acceleration. Candidates could not apply $W = F\Delta x\cos\theta$ as Δx increases with a constant net external force imply that the net work done on the block would increase.
Q 1.6 Many candidates selected **C** as their answer. Candidates confuse frequency and wavelength in the red shift of a star.
Q 1.7 Many candidates selected **A** as their answer. The use of ratios in mathematical relationship was a huge challenge for candidates in this sub-question. Candidates did not know that electrostatic force between Q_1 and Q_2 is equal to the electrostatic force between Q_1 and Q_3. Since the distance between Q_1 and Q_3 is three times greater the force would be 9 times smaller, therefore Q_3 must be 9 times greater so that the electrostatic forces are equal to each other at Q_1.
Q 1.8 The sub-question was poorly answered with a **variety of incorrect answers**. Candidates do not know that power or energy can be used to determine the brightness of lightbulbs. Candidates could not use $P = I^2R$ correctly to compare the brightness of the lightbulbs.
Q 1.9 Many candidates selected **B** as their answer. Candidates only know that commutators ensure direct current. Candidates do not know how commutators ensure direct current by reversing the current so that the current does not change direction after each cycle.
Q 1.10 Many candidates selected **A** as their answer. Candidates could not rearrange the Photoelectric effect equation $E = Ek_{(max)} + W_o$ into general form of a straight line y = mx +c. The Photoelectric effect equation becomes $E_{k(\max)} = hc\frac{1}{\lambda} + W_o$.

Provide suggestions for improvement in relation to Teaching and Learning.

Multiple-choice questions test the understanding of laws, principles and concepts in Physics. Multiple-choice questions must be used as a tool to eliminate misconceptions that learners may have on a particular topic. Educators and subject advisors are encouraged to draft multiple choice questions and incorporate it into their informal daily activities.

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

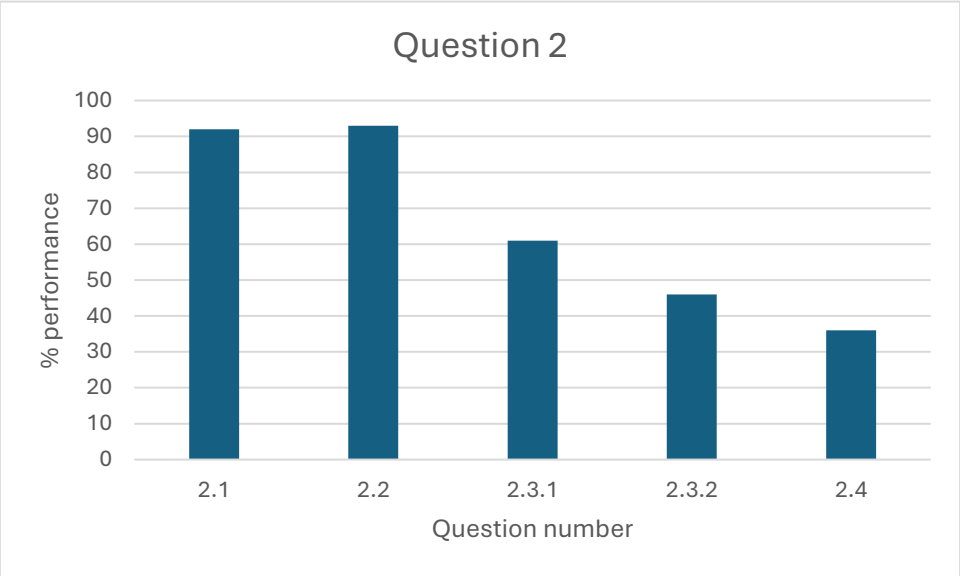
Multiple-choice questions consist mainly of level 2 and 3 questions. Educators must give test that only consist of multiple-choice questions so that learners can develop the skill that eliminates the obvious incorrect distractors in multiple-choice questions.

QUESTION 2: NEWTON'S LAWS OF MOTION

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

The question had a good performance at an average of 62 %. Sub-question 2.2 was the best performing question at an average of 93 % while sub-question 2.4 was the worst performing sub-question at an average of 36 %.

QUESTION NUMBER	% PERFORMANCE
2.1	92
2.2	93
2.3.1	61
2.3.2	46
2.4	36



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

Q 2.1 Question had a good overall performance as Newton's second law of motion has been asked numerous times however some candidates still commit the following errors:

Omission of key words: "net/resultant" in the " net force" or simply stated the law incorrectly as:

The net force is directly proportional to the acceleration and inversely proportional to the mass of the object.

NB: Learners will have to write the whole statement as in the *2021 Exam Guidelines* in order to get 2 marks. The relationship alone will no longer be accepted from 2026 e.g.

"Acceleration is directly proportional to net force and inversely proportional to mass of the object" will not be accepted for 2 marks.

Q2.2 The free-body diagram was well answered and the best performing sub-question.

Common errors in the free-body diagram are no arrows or arrows not touching the dot. Candidates draw the component of F (18 N) which is not accepted; f_k instead of f_s^{max}.

Candidates still do not know the accepted labels for the various forces e.g labelled frictional force as f_r instead of $f/f_s/f_s^{max}$.

Q2.3.1 The question was well answered as it was a basic grade 10 mathematics trigonometry question or use of Pythagoras. However, these types of questions are rarely asked some learners could not identify the correct trigonometric ratio.

Q2.3.2 Question was generally well answered. Candidates could not calculate the normal force, and others equate the normal force to gravitational force (F_g). Omitting the vertical component of the applied force (F). Some wrote $f_s = \mu_s N$ or $f_s = \mu_k N$ instead of $f_s^{max} = \mu_s N$.

Q 2.4 Question was poorly answered generally. Candidates could not apply the equations to answer the question e.g. Increase uses the equation $f_s^{max} = \mu_s N$ whereas the angle (θ) decreases the vertical component of the applied force (F) decreases, the normal force (N) increases by $N = F_g - F\sin\theta$ while μ_s remains constant.

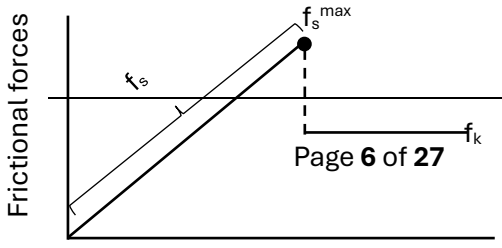
Decreases, uses the equation $F_{net} = F\cos\theta - f$, as the angle ($\theta$) decreases then the horizontal component of the applied force (F) increases. The block will now move since F_x is greater than f_s^{max} and $f_k < f_s^{max}$.

Provide suggestions for improvement in relation to Teaching and Learning.

Teachers should provide learners with copies of the *2021 Examination Guidelines,* highlight the definitions in the examination guidelines. Definitions should form part of informal assessments to ensure learners thoroughly memories the definitions. The examination guideline should also be used to emphasize the accepted labels and units for the various physical quantities.

Teachers should emphasize the importance of free-body diagrams and apply it to solve problems. This would ensure that learners understand free-body diagrams and are able to identify the correct forces that are needed in calculations.

Teachers must carry out experiments to demonstrate differences in static frictional force (f_s), maximum static frictional force (f_s^{max}) and kinetic frictional forces. The following diagram must also be used in explaining the differences in frictional forces.



Applied force

For questions that requires an explanation involving relationships, the learners must use a formula, law or principle in their explanation. Learners must be able to identify the independent variable (the change that was made) , the dependent variable (the affected variable) and the constant variable in the explanation e.g Q2.4 $f_s^{max} = \mu_s N$ by changes the angle (θ) the normal force was affected, the change in the normal force will affect f_s^{max} as the quantities are directly proportional as μ_s remains constant.

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

Teachers should give learners equations and change one physical quantity to the equation and allow learners to reason with the equation how certain quantities will be affected. This will greatly assist learner in answering questions that need an explanation.

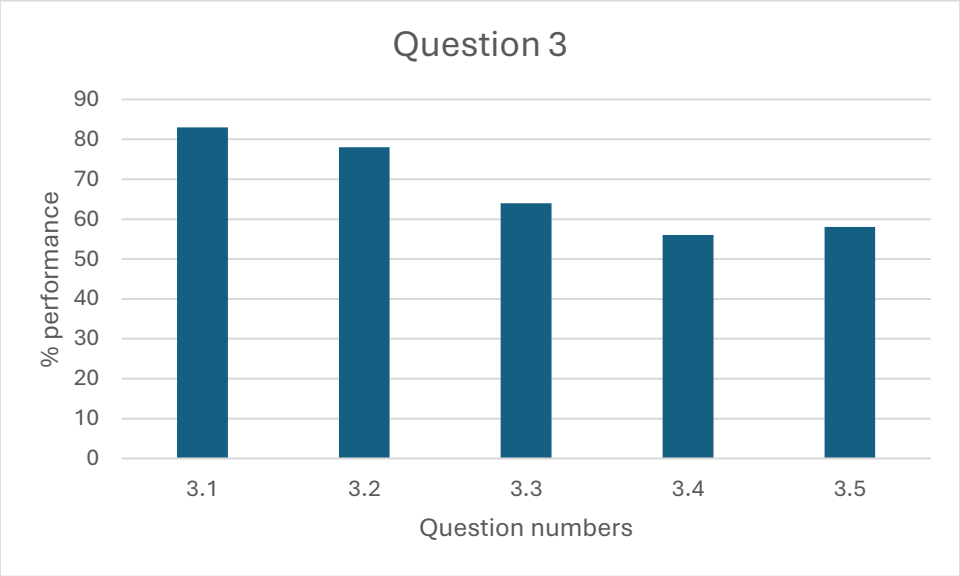
The use of youtube, PHET simulations and basic experiments are encouraged to ensure that there is a deep understanding rather than memorization of facts.

QUESTION 3: VERTICAL PROJECTILE MOTION

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

The question had a good performance at an average of 66 %. Sub-question 3.1 was the best performing question at an average of 83 % while sub-question 3.5 was the worst performing sub-question at an average of 56 %.

QUESTION NUMBER	% PERFORMANCE
3.1	83
3.2	78
3.3	64
3.5	56
3.6	58



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

Q3.1 This was an easy recall question. However, candidates still omitted key words or defined projectile motion and forfeited both (2) marks.

Key words omitted: "*only*" and some wrote *gravity* instead of *gravitational force* or *weight*.

Q 3.2 Question was generally well answered. Candidates struggled with vector nature of physical quantities in the equations of motion e.g. the initial velocity is upward and gravitational acceleration is downwards thus the signs must be opposite. Some could not interpret the information in the table to the motion of the ball and use the wrong formula to calculate the value of *p*.

Q 3.3 Some candidates changed the direction of motion of the ball in their calculations and forfeited all the marks e.g $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$

$$5 = v_i(3{,}36) + \tfrac{1}{2}(-9{,}8)(3{,}36)^2$$

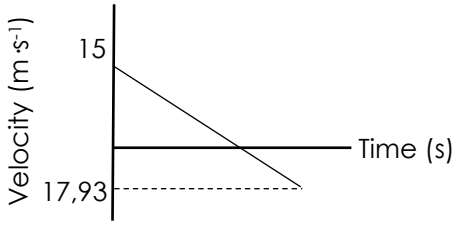
Using the speed with which the ball strikes the ground as the speed with which the ball was projected. Candidates did not know that time is 3,36 s is the time taken from the projection of the ball until the ball strikes the ground. Candidates simply substituted 3,36 s into any time Δt for various equations. E.g $v_f = v_i + a\Delta t$

$$v_f = 0 + (-9{,}8)(3{,}36)$$

Candidates struggled with vector nature of physical quantities in the equations of motion e.g. the initial velocity is upwards and gravitational acceleration and the displacement downwards thus the signs must be opposite to initial velocity at which the ball was projected.

Q 3.4 Most candidates forfeited one mark by not comparing the original displacement (height) of the ball to the displacement (height) of the ball after the bounce. Some just wrote the generally explanation of inelastic collisions in their explanation e.g $\sum E_k$ (before) $\neq \sum E_k$ (after) without understanding the concept. Other used referred to mechanical energy instead of kinetic energy to explain an inelastic collision.

Q 3.5 Generally well answered. Majority of the candidates did not draw the velocity-time graph of the ball after the bounce or did not stop the graph at the maximum height. Thus, forfeiting one mark e.g.



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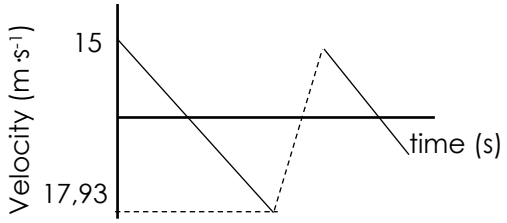


Provide suggestions for improvement in relation to Teaching and Learning.

Teachers should provide learners with copies of the *2021 Examination Guidelines,* highlight the definitions if the examination guidelines. Definitions should form part of informal assessments to ensure learners thoroughly memories the definitions.

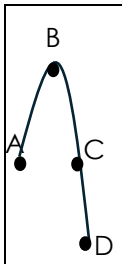
Educators should explain that the term *projectile* refers to *an object* while *freefall* describe the *motion*. Candidates will then understand the difference and not use them interchangeable when asked to define *projectile* or *free-fall*.

Educators should work with co-ordinates when teaching projectile motion and the vector nature of velocity, acceleration and displacement in the equations of motion. Learners can use the correct set of co-ordinates when substituting into a given formula and track the

motion of the *projectile* as given in question paper and not construct their own motion for the *projectile* e.g.

- Choose the motion between two points (co-ordinates).
- Choose the vector sign (motion upward positive or downward negative).
- Select the equation from the formula sheet that has all the physical quantities except for the physical quantity that needs to be calculated.

Upward motion positive (downward motion negative)	**Downward motion positive (upward motion is negative)**
• If the object is displaced upward (above the reference point) then the displacement is positive. • If the object is displaced downward (below the reference point) then the displacement is negative.	• If the object is displaced upward (above the reference point) then the displacement is negative. • If the object is displaced downward (below the reference point) then the displacement is positive.
• If the motion is upward then the velocity is positive. • If the motion is downward then the velocity is negative.	• If the motion is upward then the velocity is negative. • If the motion is downward then the velocity is positive.
• Acceleration is downward so it is negative.	• Acceleration is downward so it is positive.



Choose motion A –D

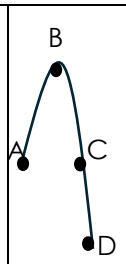
Motion upward positive

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

$v_f^2 = (15)^2 + 2(-9,8)(-5)$

$v_f = -17,97 \text{ m·s}^{-1}$

$v_f = 17,97 \text{ m·s}^{-1}$



Choose motion C –D

Motion upward positive

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

$v_f^2 = (-15)^2 + 2(-9,8)(-5)$

$v_f = -17,97 \text{ m·s}^{-1}$

$v_f = 17,97 \text{ m·s}^{-1}$

Graphical Analysis of projectiles:

Educators should relate the equations in Physical Sciences to the general equations that learners use in Mathematics. Learners will be able to understand the graphical analysis much better rather than memorize graphs for the various scenarios.

Educators should use the equation $v_f = v_i + a\Delta t$ and rearrange in the form **y = mx + c**
e.g. $\mathbf{v_f = a\Delta t + v_i}$ and track the motion of the projectile with a straight-line graph for velocity-time graph.

The equation $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ can be rearrange in the form **$y = ax^2 + bx + c$** e.g. **$\Delta y = \frac{1}{2}a\Delta t^2 + v_i\Delta t$** . This equation then informs the learner that the displacement - time graph for a projectile is a parabolic shape.

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

Educators should consult the *2021 Examination Guidelines* for the various scenarios that can be tested in Projectile motion. When bouncing objects are tested integration of inelastic and elastic collisions can be tested.

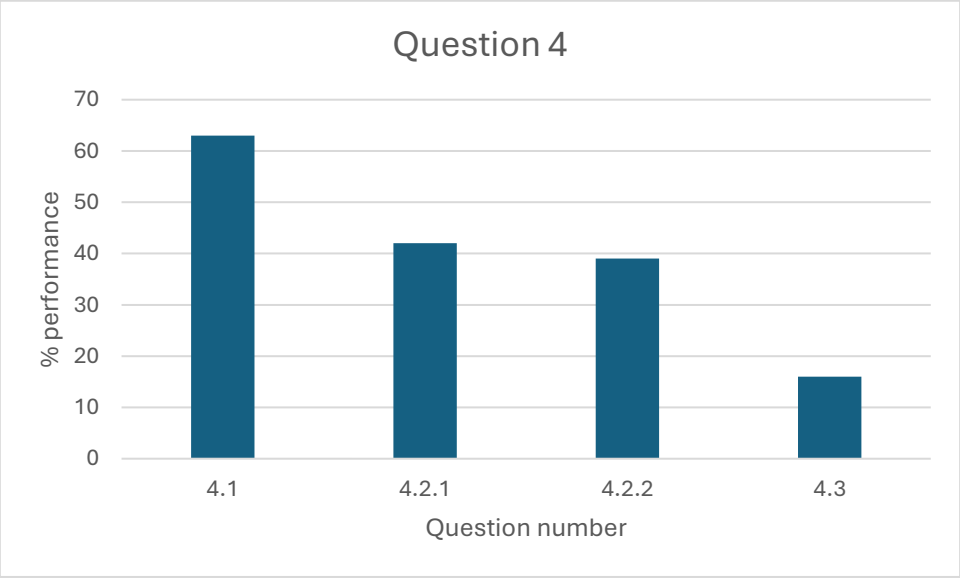
Educators should give the formula sheet to the learners to paste in their books. Learners must then be able to use the formula sheet to the required question e.g. Question 3 deals with motion of *projectiles* and formula sheet does have headings to the different formulae in the formula sheet. Candidates must know that *MOTION* equations go together with Question 3.

QUESTION 4: MOMENTUM AND IMPULSE

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

This was the worst performing question in the question paper at an average of 40 %. Sub-question 4.1 was the best performing question at an average of 63 % while sub-question 4.3 was the worst performing sub-question at an average of 16 %.

QUESTION NUMBER	% PERFORMANCE
4.1	63
4.2.1	42
4.2.2	39
4.3	16



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

Q 4.1 This was a level 1 recall question. This definition was not asked in the previous NCS examination. Candidates forfeited marks due to the omission of key words: "resultant/ net", "product" or "contact time". Others simply stated impulse is the product of the net force and rate of change in time.

Q 4.2.1 An unfamiliar graph was given to the candidates. Candidates did not read the vertical axes and horizontal axes of the graph. The vertical axes represented the **final momentum** and the horizontal axes represented by **contact time.** Candidates answered incorrectly as follows:

<table>
<tr>
<td>$F_{net} = \frac{\Delta p}{\Delta t}$

$F_{net} = \frac{4,5 - 0}{0,03 - 0,01}$</td>
<td>$F_{net} = \frac{\Delta p}{\Delta t}$

$F_{net} = \frac{4,5}{0,03}$</td>
<td>$F_{net}\Delta t = \Delta p$

$F_{net}(0,03) = 4,5$</td>
<td rowspan="2">Correct interpretation

$\text{gradient}/F_{net} = \frac{\Delta p_f}{\Delta(\Delta t)}$
$F_{net} = \frac{4,5 - 0}{0,03 - 0,01}$</td>
</tr>
<tr>
<td colspan="3">In these options the candidates says that the initial momentum of the ball is zero (0) which is a conceptual issue since the ball was given an initial momentum.</td>
</tr>
</table>

Candidates also forfeited the final answer since they did not include the direction of the net/resultant force.

Q 4.2.2 This question was poorly answered. Candidates struggled to interpret the graph and hence, could not answer this question. Candidates could not manipulate $F_{net}\Delta t = p_f - p_i$ into y = mx + c where it will show that the y intercept represent the initial momentum (p_i).

Candidates could not use the points on the graph to calculate initial momentum (p_i) of the ball and then calculate the magnitude of the initial velocity of the ball.

Q 4.3 This was a higher order question, and it was poorly answered. Candidates could not use the equation p = mv to determine that a greater mass would result in higher momentum and that would shift the graph to the right. Since F_{net} which was constant and represents the gradient which meant that the second line would be parallel to the original line.

Provide suggestions for improvement in relation to Teaching and Learning.

Teachers should provide learners with copies of the *2021 Examination Guidelines,* highlight the definitions if the examination guidelines. Candidates should use equation to assist them in writing definitions and laws e.g. Impulse = $F_{net}\Delta t$

Teachers should use different types of data when teaching this topic. The data should be represented in a table or graphically so that learners can be used to interpret data graphically. Mathematical skills such as graphical analysis to interpret data as outlined in Section 2 of the CAPS document should be incorporated into daily teaching.

Vector quantities such as velocity, forces and displacement should be reinforced in grade 12. Candidates will not omit the direction when asked to calculate vector quantities.

Teachers should use equations to reason and interpret information. Allow learners to plot their values graphically so they can see the impact of the change in the independent variable on the dependent variable.

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

Experiment / PHET simulation / youtube should be used in class to demonstrate the practical nature of conservation of linear momentum, momentum and impulse. The concept of *impulse* should be taught from Newton's 2nd law. If a net force is applied to an object it will result in a change in the objects momentum for the duration of the net force.

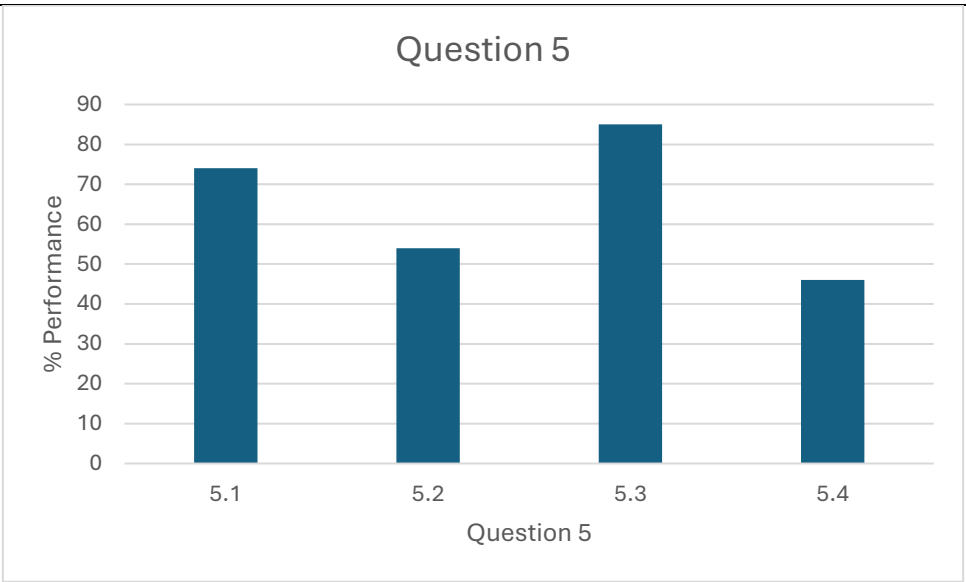
Educators should train learners that formulae sheet include forces which is applicable to question 4.

QUESTION 5: WORK, ENERGY AND POWER

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

The question had a good performance at an average of 61 %. Sub-question 5.3 was the best performing question at an average of 85 % while sub-question 5.4 was the worst performing sub-question at an average of 46 %.

QUESTION NUMBER	% PERFORMANCE
5.1	74
5.2	54
5.3	85
5.4	46

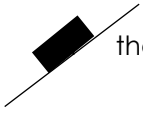


Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions

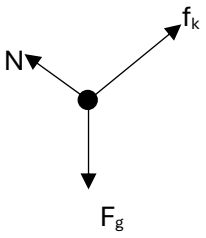
Q 5.1 This question was generally well answered. A few minor issues like omitting key words "total / net" and "change" and "same" instead of "equal to" while other wrote "rate of change in kinetic energy"

Q 5.2 Candidates calculate ΔE_K instead of E_K at point B. Some candidates write $W = F\Delta x$ instead of $W = F\Delta x\cos\theta$ and then substituted in $W = F\Delta x$.

Q 5.3 The free-body diagram was well answered. Some candidates change the direction of the incline e.g.

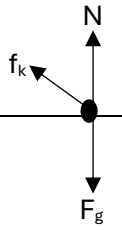


then the free-body diagram becomes:



This is not accepted. Candidates cannot change the direction of the incline.

The normal force (N) was also not drawn perpendicular to the surface e.g.



Q 5.4 Candidates substituted negative values for forces in $W = F\Delta x\cos\theta$. This equation only uses magnitudes for F and Δx when substituting into the equation. The angle (θ) will address if the negative or positive work is done. Candidates could not identify what to calculate and reason against the given scenario. The question asked candidates to proof that the distance covered by the crate is larger than 6,8 m. Candidates mix which forces is needed for W_{nc} and W_{net}.

Candidates still lack the insight into using $\cos 0^{o}$ and $\cos 180^{o}$.

Calculation for the work done by the gravitational force was a challenge for many candidates.

Provide suggestions for improvement in relation to Teaching and Learning.

Teachers should provide learners with copies of the *2021 Examination Guidelines,* highlight the definitions in the examination guidelines. Formula should be used when defining the work-energy principle.

The formula $W_{nc} = \Delta E_K + \Delta E_p$, W_{nc} is the work done by the non-conservative forces in this case it was work done by the frictional force and $W_{net} = \Delta E_K$, W_{net} refers to the work done by all the forces that affects the motion of the object.
The following options can be used to calculate the work done by the gravitational force:
$W_{Fg} = -\Delta Ep$ or $W_{Fg} = F\Delta x\cos\theta$ where θ is the angle between gravitational force and the surface.

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

Educators must practice examples that require complex reasoning.

Free-body diagrams must be used when performing calculations.

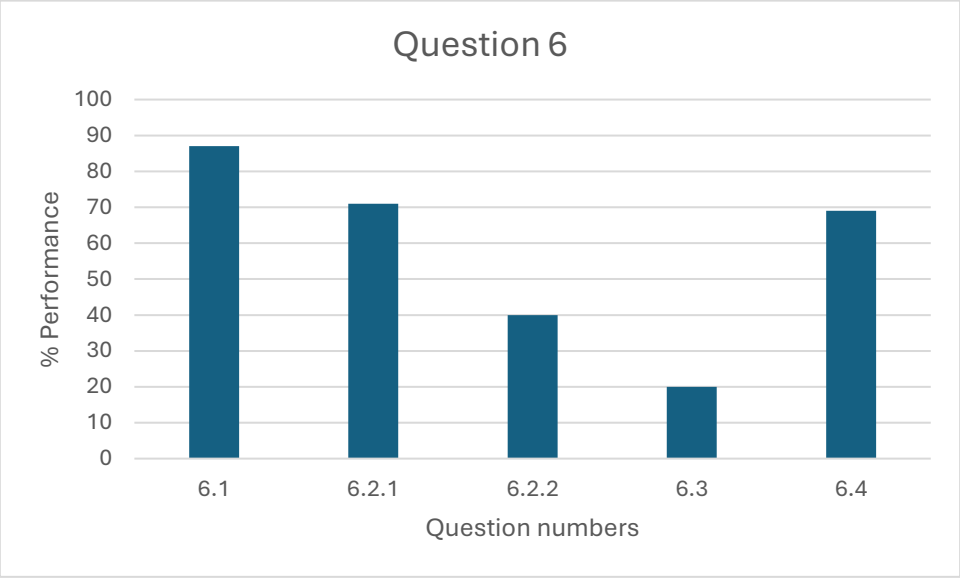
Educators should train learners that formulae sheet include work, energy and power formulae which is applicable to question 5 along with the force's formulae table.

QUESTION 6: DOPPLER EFFECT

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

The question had a moderate performance at an average of 62 %. Sub-question 6.1 was the best performing question at an average of 87 % while sub-question 6.3 was the worst performing sub-question at an average of 20 %.

QUESTION NUMBER	% PERFORMANCE
6.1	87
6.2.1	71
6.2.2	40
6.3	20
6.4	69



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

Q 6.1 Most candidates were able to state the Doppler effect with some omitting key words "change" in frequency, "relative motion" or "medium" and some wrote " *medium of sound*" instead of "*Medium of sound propagation*"

Q 6.2.1 Most candidates were able to answer this question. Common error is that candidates wrote *velocity* instead of *velocity of the ambulance/source*.

Q 6.2.2 Many candidates could not identify the controlled variable. Most candidates said *frequency* which was incorrect. There are two frequencies: the *frequency detected* and *frequency emitted by the sound source*.

Q 6.3 Sub-question was poorly answered. The effect on the change of the speed of a source or observer on the detected frequency was not asked before. Candidates could not interpret the relationship between v_s and f_L.
Candidates referred to the motion of the sound source and the wavelength e.g as the source is moving away the detected frequency decreases or the wavelength increases.

When writing a conclusion candidates are expected to write the relationship between the independent and dependent variable. E.g. As the independent variable increases/decreases the dependent variable increases/decreases.

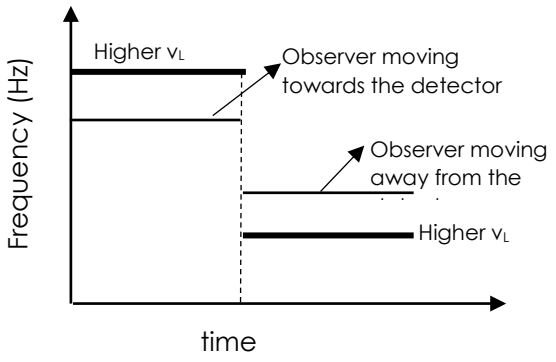
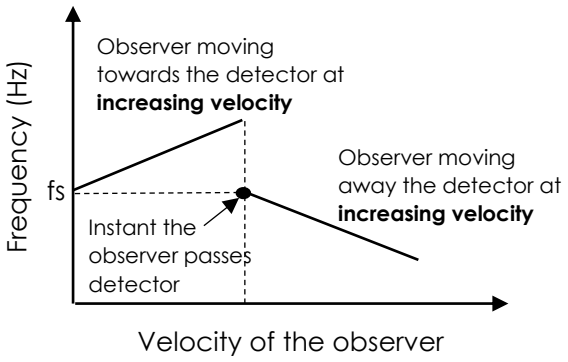
Q 6.4 The sub-question was generally well answered. Candidates could not interpret the graphs to identify the motion of the ambulance. Candidates could not identify that there were two detected frequencies and same emitted frequency they used the one as the frequency of the source and the other as the detected frequency e.g.

$f_L = \frac{v}{v - v_s} f_s$	$f_L = \frac{v}{v + v_s} f_s$
$1298 = \frac{v}{v - 25} 1115$	$1115 = \frac{v}{v + 25} 1298$

Provide suggestions for improvement in relation to Teaching and Learning.

Teachers should provide learners with copies of the *2021 Examination Guidelines,* highlight the definitions in the examination guidelines.

Learners must be taught in the Doppler effect there are two frequencies. The frequency emitted by the sound source and the detected frequency due to the Doppler effect. The detected frequency will only change if the speed of the source or observer increases or decreases. If the source is moving towards or away at a constant speed then the detected frequency is either constant higher or constant lower than the source frequency, but the detected frequency remains constant see diagram below.

DOPPLER EFFECT EXPERIMENT GRAPHS	
The observer moving at constant velocity **Stationary source**	**The observer accelerating** **Stationary source**
	

Learners must also be taught that there are three speeds: either the speed of the source or speed of the observer and the speed of sound in the medium. Learners must know that either the source or the observer will move.

Educators must represent the Doppler effect data in either a table or in a graph. Section 2 of the CAPS document deals with skills that Physical Sciences learners should have by the end of the CAPS curriculum for Physical Sciences.

When writing a conclusion, investigative question or hypothesis learners must refer to the independent and dependent variable.

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

Educators should install frequency detecting app on their phones/ use data from the internet and allow learners to do the Doppler effect experiment. The speed of sound depends on various factors such temperature, density and type of media. Educators should bring this to the attention of learners.

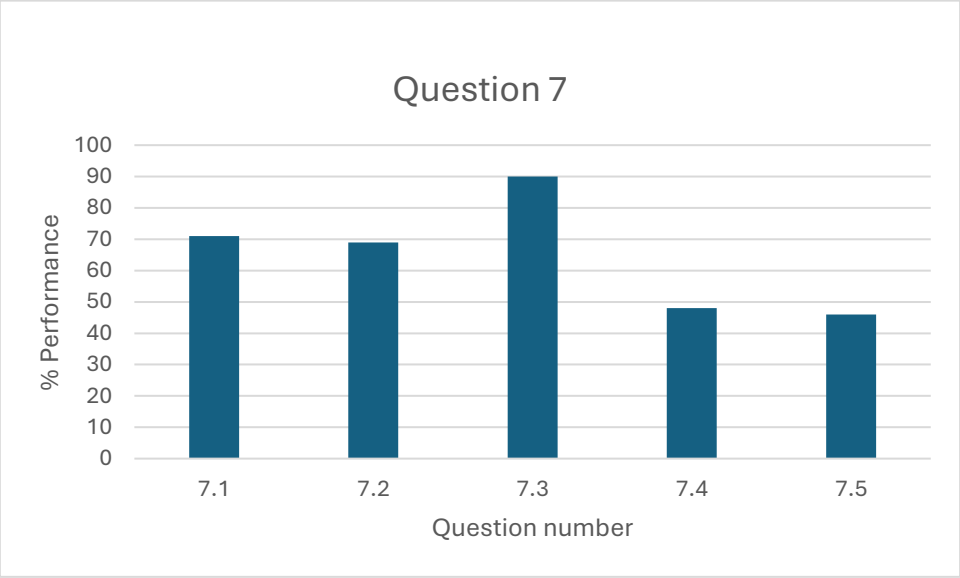
When a graph is given the independent and dependent variable is given. The equation can be used to identify the controlled variable. The physical quantity in equation that is not listed as an independent or dependent variable should be the controlled variable.

QUESTION 7: Electrostatics (Coulomb's law and electric fields)

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

The question had a good performance at an average of 62 %. Sub-question 7.3 was the best performing question at an average of 90 % while sub-question 7.5 was the worst performing sub-question at an average of 46 %.

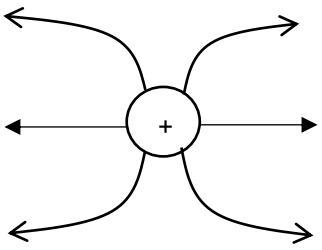
QUESTION NUMBER	% PERFORMANCE
7.1	71
7.2	69
7.3	90
7.4	48
7.5	46



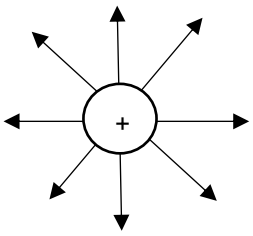
Why was the question poorly answered? Also provide specific examples, indicate common errors committed by learners in this question, and any misconceptions

Q 7.1 The sub-question was generally well answered. A few candidates omitted key words "charge" and "region/space" others defined *electric field at a point*. Other common error response is "*A region in space in which an electric* ***force*** *experiences a force*" and "*A region in space in which an electric* ***force*** *experiences a charge*".

Q 7.2 Generally well answered with most candidates forfeiting a mark for shape e.g.



Instead of



Candidates also forfeited marks since the field lines entered the sphere. Field lines should not cross nor enter the charged sphere.

Q 7.3 The sub-question was well answered. Some candidates copied the formula incorrectly from the formula sheet or tried to remember the formula and wrote down the incorrect formula e.g $E = \frac{kQ_1Q_2}{r^2}$ instead of $F = \frac{kQ_1Q_2}{r^2}$.

Q 7.4 This question was integrated with frictional forces in electrostatic forces. This put many candidates off. Candidates did not know what they must proof. It was a similar problem to question 5.4.
Candidates wrote the incorrect formula. Some candidates copied the formula incorrectly from the formula sheet or tried to remember the formula and wrote down the incorrect formula.
e.g $E = \frac{kQ_1Q_2}{r^2}$ instead of $F = \frac{kQ_1Q_2}{r^2}$
Candidates substituted the negative values of the charges into the equation $F = \frac{kQ_1Q_2}{r^2}$.
Candidates did not assign direction to the electrostatic forces which were in opposite directions.

Q 7.5 This was the worst performing sub-question. Candidates could not use $Q = \frac{Q_1+Q_2}{2}$ determine that the magnitude of Q_y and Q_x would decrease and using Coulomb's law to derive that electrostatic force is directly proportional to the product of the charges. If the magnitude of the charges decreases than the electrostatic force will also decreases.

Provide suggestions for improvement in relation to Teaching and Learning.

The definitions from the *2021 Examination guidelines* should be emphasized.

Learners should be taught that field lines originate from the charge and move radially outward from the charge (no two field lines must be parallel)

Learners must be made aware that in $E = \frac{kQ_1}{r^2}$ and $F = \frac{kQ_1Q_2}{r^2}$ only absolute (positive) values are substituted in these equations.

Forces are vector quantities and direction should be correctly assigned.

Teachers should incorporate exercises that requires reasoning with calculations.

The differences between electrostatic forces and frictional forces should be thoroughly explained where electrostatic forces exist only between charged objects/spheres and it can be incorporated with tension, applied force and frictional forces on surfaces or hanging on a light rope.

Educators should emphasize that a principle, law or formula can be used to explain the effect that the change of charges would have on the electrostatic force.

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

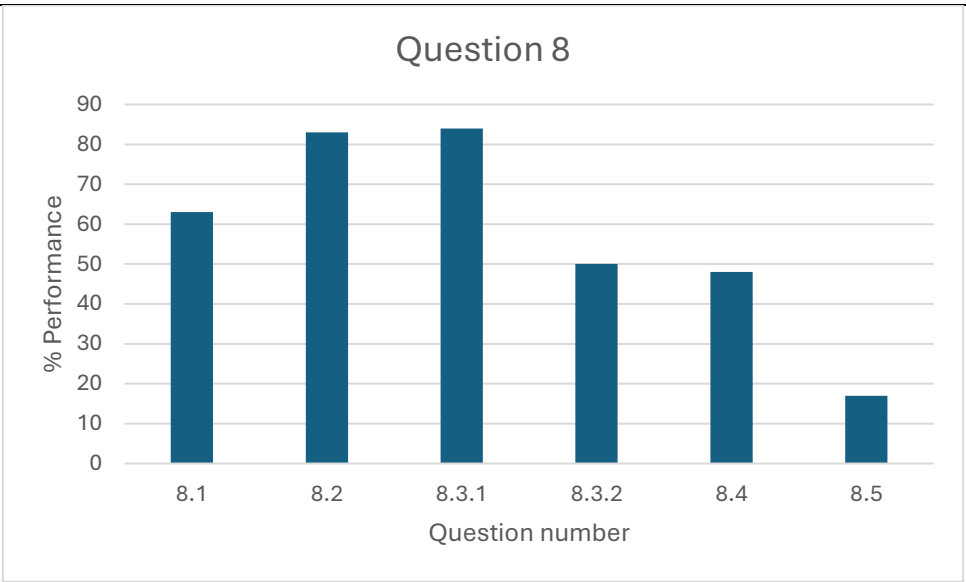
Youtube/PHET simulation should be used to demonstrate how an electric field exist around point charges. It should also be used to demonstrate the differences between an *electric field* and *electric field at a point* (strength of the field at a point).

QUESTION 8: ELECTRIC CIRCUITS

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

The question had a moderate performance at an average of 53 %. Sub-question 8.3.1 was the best performing question at an average of 84 % while sub-question 8.5 was the worst performing sub-question at an average of 17 %.

QUESTION NUMBER	% PERFORMANCE
8.1	63
8.2	83
8.3.1	84
8.3.2	50
8.4	48
8.5	17



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

Q 8.1 The performance in the sub-question was moderate. Candidates omitted key words "maximum" , "total" or "per unit charge" or some said "…energy needed by the battery…" instead "…energy provided by the battery…" while other "maximum potential difference provided by the battery"

Candidates could not interpret the circuit and struggled with Q8.2 to Q 8.5.

Q 8.2 Generally well answered. Candidates substituted the resistance of the light bulbs when calculating the current through the starter motor.

Q 8.3.1 Generally well answered. Some candidates omitted the unit in the final answer. Some candidates changed the formula to $P = L_1^2R$ instead of $P = I^2R$.

Q 8.3.2 Candidates wrote the answer from Q 8.3.1.
Candidates did not know that the current divides equally for resistors in parallel when the resistors have equal resistance.

Q 8.4 Candidates substituted current from the parallel branch with the starter motor. Others recalculated the current that will flow through the starter motor.

Candidates did not know that the internal resistance and emf were unknown.
Candidates did not know that the emf and internal resistance of the circuit when switch S_1 was closed (while S_2 was open) would be the same when switch S_2 was closed (while S_1 was open)

Q 8.5 Candidates could not identify that the two lights bulbs and the starter motor would be connected in parallel if both switches were closed.

Candidates omit "total" in total resistance and total current in their explanation.

Candidates used the equation $R = \frac{V}{I}$ to explain the relationship between current and potential difference.

Provide suggestions for improvement in relation to Teaching and Learning.

The definitions from the *2021 Examination guidelines* should be emphasized.

Electric circuits should be taught with the PHET simulation. This would make it easier for learners to see the current flow and interpret circuit diagram better.

Educators should with the aid of PHET simulation draw a variety of circuits with switches. The learners will then have the required skills to interpret a variety of circuit diagrams.

When explanations are required, the relevant law, formula or principle should be applied.

e.g Emf = V_{ext} + Ir

- Total resistance decreases
- Total current increases
- Emf and r remains constant
- V_{int} increases
- V_{ext} decreases

Teachers should refrain from teaching shorthand.

e.g Emf = V_{ext} + Ir

- Total resistance↓
- Total current↑
- V_{int} decreases ↑
- Emf —
- V_{ext} decreases↓

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

Learners should avoid arrows and symbols in explanations.

Learners must write full sentences but not in essay format.

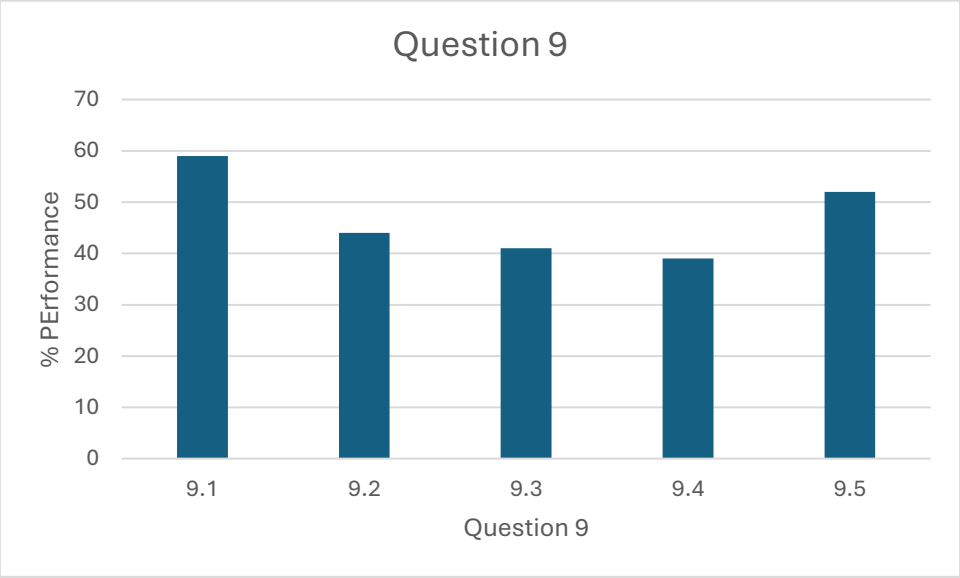
Learners must be taught to write their explanation in bullet form.

QUESTION 9: ELECTRODYNAMICS

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

The question had a moderate performance at an average of 44 %. Sub-question 9.1 was the best performing question at an average of 59 % while sub-question 9.4 was the worst performing sub-question at an average of 39 %.

QUESTION NUMBER	% PERFORMANCE
9.1	59
9.2	44
9.3	41
9.4	39
9.5	52



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

Q 9.1 Candidates omitted key words "equivalent", "energy/heat/power" and "produce/dissipates"

Q 9.2 Candidates had a misconception on the polarity of a magnet. Candidate wrote positive or negative for the polarity (poles) of the magnet. Candidates had a misconception that polarity only refers to polar nature of chemical bonds.

Candidates could not use Flemings Hand right rule.

Q 9.3 Candidates struggled with the integration of this question with cost of electricity and electrodynamics.

Candidates could not covert Watt (W) to kilowatts (kW) when calculating the cost.

Candidates omitted the subscripts in $P_{ave} = \frac{V_{rms}^2}{R}$, $P_{ave} = I_{rms}^2 R$ or $P_{ave} = V_{rms} I_{rms}$

Candidates could not recall the formula to calculate the cost or use the unit for tarrif to generate an equation to calculate the cost of electricity.

Q 9.4 Candidates did not know that double the speed will double the voltage, which doubles the amplitude.
Candidates did not know that double speed of rotation will double the frequency or half the period.
Candidates did not draw one complete cycle as instructed by the question.
Candidates drew sin curves, while other just redraw the cosine graph.

Q 9.5 Candidates wrote "add split ring/commutator" instead of "replace slip rings with split ring/commutator".

Provide suggestions for improvement in relation to Teaching and Learning.

The definitions from the *2021 Examination guidelines* should be emphasized.
Educators must thoroughly explain that polarity can refer to the poles of magnets which can be North and South pole.
Educators must use the formula sheet from alternating current so that learners do not omit subscripts in their formula.
Educators know that P = VI refers to direct current while $P_{ave} = V_{rms}I_{rms}$ refers to alternating current.
Use Faraday's law of magnetic induction to determine the factors that will influence the value of the induced emf.
Educators should plot the effect graphically the changes in current and potential differences for generators so that learners can see how to draw the graphs.
Educators should also draw the curves when changes are made to the operations of generators.

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

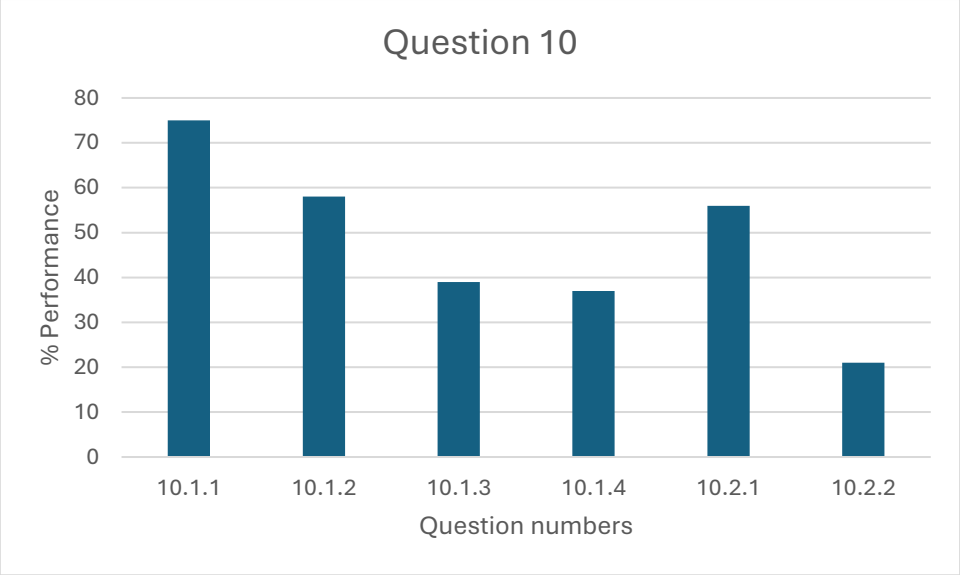
Teacher should make use youtube to demonstrate the operation of generators and motor.
Teacher should also use PHET simulation to teach this abstract topic.

QUESTION 10: PHOTOELECTRIC EFFECT

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

The question had a moderate performance at an average of 47 %. Sub-question 10.1.1 was the best performing question at an average of 75 % while sub-question 10.2.2 was the worst performing sub-question at an average of 21 %.

QUESTION NUMBER	% PERFORMANCE
10.1.1	75
10.1.2	58
10.1.3	39
10.1.4	37
10.2.1	56
10.2.2	21



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

Q 10.1.1 Candidates omitted key words "minimum", "metal surface" and other defined *threshold frequency*.

Q 10.1.2 Candidates omitted the unit hertz (Hz) while other wrote hz instead of Hz for the unit.

Candidates also wrote 0 Hz confusing maximum kinetic energy ($E_{k(max)}$) and threshold frequency.

Q 10.1.3 Candidates wrote "*smaller than*". Candidates had a misconception that the maximum kinetic energy $E_{k(max)}$ and Work function (W_o) are proportional to each other.

Candidates could not apply the equation $E = E_{k(max)} + W_o$ in their explanation. Candidates omitting that the energy/frequency of the photon remains the same.

Q 10.1.4 Many candidates answered yes in this sub-question. Candidates explained that an increase intensity increases the number of photons and thus increasing the number of photoelectrons. Candidates could not interpret the question that increasing the intensity with the same frequency will not emit electrons if the threshold frequency was not met.

Q 10.2.1 Candidates used the photoelectric effect in answering this question. Candidates do not know when to apply the photoelectric effect equation. The photoelectric effect equation is only applied when there is an ejection of photoelectrons from a metal surface or to proof whether the photoelectric effect will occur when light is shone onto a surface of a material.

Q 10.2.2 Candidates did not know quantisation of energy emitted by the electron in relation to the atomic energy levels. Candidates did not compare the atomic energy levels to the given energy of the photon. Transition only occurs with a certain amount of energy for given atomic levels.

Provide suggestions for improvement in relation to Teaching and Learning.

The definitions from the *2021 Examination guidelines* should be emphasized.

Educators should use the Laws, Equations or principles when comparing or explaining the effect on a physical quantity e.g.

Q 10.1.3 $E = E_{k(max)} + W_o$

Energy of the photon shone on both metal are the same

$E_{k(max)}$ of sodium (Na) is smaller than the $E_{k(max)}$ of Caesium (Cs)

Work function of sodium (Na) is greater than the work function of Caesium (Cs)

Educators should thoroughly explain the intensity only has an effect on the number of electrons ejected if the photoelectric occurred otherwise intensity has not effect.

The difference in the quantisation of energy in the atomic levels to the photoelectric effect should be clearly explained to learners. Learners can differentiate between the two concepts.

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

The photoelectric effect should be taught with PHET simulation to demonstrate this abstract concepts.

Educators should also expose learners to YouTube demonstrations on the photoelectric effect.

Virtual experiments using PHET simulation should be conducted to ensure learners properly grasps this concept.