basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2011

MEMORANDUM

MARKS: 150

This memorandum consists of 15 pages.

Learning Outcomes and Assessment Standards		
LO1	**LO2**	**LO3**
AS 12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables.	**AS 12.2.1:** Define, discuss and explain prescribed scientific knowledge.	**AS 12.3.1:** Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims.
AS 12.1.2: Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations.	**AS 12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in own words.	**AS 12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications.
AS 12.1.3: Select and use appropriate problem-solving strategies to solve (unseen) problems.	**AS 12.2.3:** Apply scientific knowledge in everyday life contexts.	**AS 12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally.
AS 12.1.4: Communicate and defend scientific arguments with clarity and precision.		

GENERAL GUIDELINES

1. CALCULATIONS

1.1 **Marks will be awarded for**: correct formula, correct substitution, correct answer with unit.

1.2 **No marks** will be awarded if an **incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

1.3 When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.

1.4 If **no formula** is given, but **all substitutions are correct**, a candidate will **forfeit one mark**.

1.5 When **no formula** is given, marks will be **forfeited** for **zero substitutions** not shown. Other substitutions and a correct answer will be credited.

1.6 **No penalisation if zero substitutions are omitted** in calculations where **formula**/principle is given correctly.

1.7 Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.

1.8 Marks are only awarded for a formula if a **calculation had been attempted**. i.e. substitutions have been made or a numerical answer given.

1.9 Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.

1.10 All calculations, when not specified in the question, must be done to two decimal places.

2. UNITS

2.1 Candidates will only be penalised once for the repeated use of an incorrect unit **within a question or subquestion**.

2.2 Units are only required in the final answer to a calculation.

2.3 Marks are only awarded for an answer, and not for a unit *per se*. Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:
- Correct answer + wrong unit
- Wrong answer + correct unit
- Correct answer + no unit

2.4 SI units must be used except in certain cases, e.g. $V \cdot m^{-1}$ instead of $N \cdot C^{-1}$, and $cm \cdot s^{-1}$ or $km \cdot h^{-1}$ instead of $m \cdot s^{-1}$ where the question warrants this.

3. GENERAL

3.1 If one answer or calculation is required, but two given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.

3.2 For marking purposes, alternative symbols (s,u,t, etc.) will also be accepted

3.3 Separate compound units with a multiplication dot, not a full stop, for example, $m \cdot s^{-1}$.
For marking purposes $m.s^{-1}$ and m/s will also be accepted.

4. POSITIVE MARKING

Positive marking regarding calculations will be followed in the following cases:

4.1 **Subquestion to subquestion:** When a certain variable is calculated in one subquestion (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3, **full marks** are to be awarded for the subsequent subquestions.

4.2 **A multistep question in a subquestion**: If the candidate has to calculate, for example, current in the first step and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

4.3 If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.

4.4 Questions where a series of calculations have to be made (e.g. a circuit diagram question) do not necessarily always have to follow the same order. FULL MARKS will be awarded provided it is a valid solution to the problem. However, any calculation that will not bring the candidate closer to the answer than the original data, will not count any marks.

4.5 If one answer or calculation is required, but two given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.

4.6 Normally an incorrect answer cannot be correctly motivated if based on a conceptual mistake. If the candidate is therefore required to motivate in question 3.2 the answer given to question 3.1, and 3.1 is incorrect, no marks can be awarded for question 3.2. However, if the answer for e.g. 3.1. is based on a calculation, the motivation for the incorrect answer in 3.2 could be considered.

SECTION A

QUESTION 1

1.1	Momentum ✓	[12.2.1]	(1)
1.2	Coherent (sources) ✓	[12.2.1]	(1)
1.3	(Line) absorption ✓	[12.2.1]	(1)
1.4	Resistance ✓	[12.2.1]	(1)
1.5	Photons ✓	[12.2.1]	(1)
			[5]

QUESTION 2

2.1	A ✓✓	[12.2.1]	(2)
2.2	D ✓✓	[12.2.2]	(2)
2.3	C ✓✓	[12.1.2]	(2)
2.4	A ✓✓	[12.2.1]	(2)
2.5	B ✓✓	[12.2.1]	(2)
2.6	B ✓✓	[12.2.3]	(2)
2.7	D ✓✓	[12.2.1]	(2)
2.8	D ✓✓	[12.2.1]	(2)
2.9	C ✓✓	[12.1.2]	(2)
2.10	A ✓✓	[12.1.2]	(2)
			[20]

TOTAL SECTION A: 25

SECTION B

QUESTION 3

- **PENALISE ONLY ONCE FOR NOT ROUNDING OFF FINAL ANSWERS TO TWO DECIMAL PLACES.**

3.1 Gradient of the graph is constant. ✓✓ [12.1.2] (2)

3.2 At t = 1 s ✓ and t = 3 s✓ [12.1.2] (2)

3.3 $V_{AB} = V_{AC} + V_{CB}$
$= -10 + (-10)$
$= -20\ m\cdot s^{-1}$
$= 20\ m\cdot s^{-1}$ ✓✓downwards ✓

OR
$V_{AB} = V_{AC} – V_{BC}$
$= -10 - 10$
$= -20\ m\cdot s^{-1}$
$= 20\ m\cdot s^{-1}$ ✓✓downwards ✓

OR
$V_{AB} = V_A – V_B$ (vector difference)
$= -10 – (10)$
$= -20\ m\cdot s^{-1}$
$= 20\ m\cdot s^{-1}$ ✓✓downwards ✓

[12.1.2] (3)

3.4

OPTION 1
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
$= (0)(4) + ½\ (10)(4)^2$✓
$= 80$ m✓ (78,4 m if a = 9,8 $m\cdot s^{-2}$)

OPTION 2
$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$(40)^2 = (0)^2 + 2(10)\Delta y$✓
$\Delta y = 80$ m ✓ (81,63 m if a = 9,8 $m\cdot s^{-2}$)

OPTION 3
$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓
$= \left(\frac{40 + 0)}{2}\right)(4)$ ✓
$= 80$ m✓

Accept:
$s = ut + ½\ at^2$
$v = u + at$
$v^2 = u^2 + 2as$
$s = \left(\frac{v + u}{2}\right)t$
Accept formulae if *a* is replaced with *g*

[12.2.3] (3)

3.5 Displacement ✓✓ / Change in position
Accept: distance [12.2.1] (2)

3.6

(Accept: y / Δx / x for distance)

Distance covered by object B

$\Delta y = \frac{1}{2}bh + lb$ ✓

= ½ (1)(10) + (10)(1)✓

= 15 m

Distance covered by object A

$\Delta y = \frac{1}{2}bh$ ✓

= ½ (1)(-10) ✓ Accept: ½ (1)(10)

= - 5 m = 5 m

Distance between A and B = 15 – (-5) = 20 m ✓

Accept:
Distance between A and B = 15 + (5) = 20 m ✓

[12.1.3] (5)
[17]

QUESTION 4

4.1 $K / E_k = ½ mv^2$ ✓
$37,5 = ½ (12)v^2$ ✓
$v = 2,5 \ m \cdot s^{-1}$ ✓ [12.2.3] (3)

4.2 The total linear momentum remains constant / is conserved (in magnitude and direction) ✓in a closed system. ✓

OR
In a closed system, ✓ the total linear momentum before collision is equal to the total linear momentum after collision. ✓ [12.2.1] (2)

4.3 $\Sigma p(before) = \Sigma p(after)$ ✓
$(30)v_i$ ✓+ (12)(2,5) ✓= (30 + 12) (3,2) ✓
$\therefore v_i = 3,48 \ m \cdot s^{-1}$ ✓

Other formulae:
$p_t(before) = p_t(after)$
$m_1v_{i1} + m_2v_{i2} = m_1v_{f1} + m_2v_{f2}$
$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
Accept: $p_{before} = p_{after}$
$p_i = p_f$

If no subscripts:
e.g. mv + mv = mv + mv Max. $\frac{4}{5}$

[12.2.3] (5)

4.4

OPTION 1	**OPTION 2**
Trolley X: $F_{net}\Delta t = m\Delta v$ ✓ OR $F_{net}\Delta t = \Delta p$ $F_{net}(0,2)$ ✓ = 30(3,2 – 3,48) ✓ F_{net} = -42 N ∴ magnitude of F_{net} = 42 N✓	**Trolley X:** $v_f = v_i + a\Delta t$ 3,2 = 3,48 + a(0,2) ✓ a = -1,4 m·s^{-2} F_{net} = ma = (30)(-1,4) ✓ = -42 N Magnitude of F_{net} = 42 N ✓ ✓ for both formulae
OPTION 3 **Trolley Y:** $F_{net}\Delta t = m\Delta v$ ✓ OR $F_{net}\Delta t = \Delta p$ $F_{net}(0,2)$ ✓ = 12(3,2 – 2,5) ✓ F_{net} = 42 N✓	**OPTION 4** **Trolley Y:** $v_f = v_i + a\Delta t$ 3,2 = 2,5 + a(0,2) ✓ a = 3,5 m·s^{-2} F_{net} = ma = (12)(3,5) ✓ = 42 N✓ ✓ for both formulae

[12.2.3] (4)
[14]

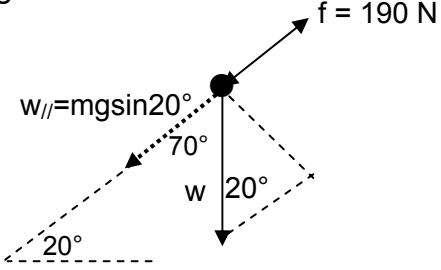
QUESTION 5

5.1 R: Force of incline (surface) on crate / N / Normal (force) / F_N ✓
S: Gravitational force / Gravity / force of Earth on crate / F_g / w / $F_{Earth\ on\ crate}$ ✓
T: Frictional force/F_f /$F_{friction}$ /f✓ [12.1.2] (3)

5.2 The force is <u>perpendicular</u> <u>to</u> ✓ <u>the displacement</u> ✓of the crate.

OR
W = F Δx cos 90° ✓ = 0 ✓ [12.2.1] (2)

5.3 The following diagram is used for clarification in the solutions below.



OPTION 1	
W_{net} = W_w + W_f ✓ = mgΔxcos70° + fΔxcos180° = <u>(70)(9,8)</u> ✓ <u>(12)(cos70°)</u>✓ + <u>(190)(12)(-1)</u> ✓ W_{net} = 535,51 J ✓	Accept: cos180° or -1

5.3

OPTION 2

$F_{net} = w_{//} + f$
$= mg\sin 20° + (-190)$
$= \underline{(70)(9,8)\sin 20°}$✓ – 190 ✓
$= 44,63$ N

Accept:
cos0° or 1

$\therefore W_{net} = F_{net}\Delta x\cos\theta$✓
$= (44,63)(12)(\cos 0°)$ ✓
$W_{net} = 535,51$ ✓

OPTION 3

$W_{net} = W_{w//} + W_f$ ✓
$= mg\sin 20°\Delta x\cos 0° + f\Delta x\cos 180°$
$= \underline{(70)(9,8)}\sin 20°$✓ $\underline{(12)\cos 0°}$✓+ $\underline{(190)(12)\cos 180°}$✓
$W_{net} = 535,51$ J ✓

Accept:
cos0° or 1
cos180° or -1

OPTION 4

$W_{net} = W_w + W_f$ ✓
$= mgh\cos 0° + f\Delta x\cos 180°$
$= (70)(9,8)$ ✓ $(12\sin 20°)\cos 0°$✓+$\underline{(190)(12)\cos 180°}$✓
$W_{net} = 535,51$ J ✓

Accept:
cos0° or 1
cos180° or -1

[12.1.3] (5)

5.4 The net work done (on an object) ✓is equal to the change in (the object's) kinetic energy. ✓

OR

The work done (on an object) by a net force is equal to the change in (the object's) kinetic energy. [12.2.1] (2)

5.5 $W_{net} = \Delta K$✓ (OR $W_{net} = \Delta E_k$)
$535,51 = ½\ m(v_f^2 - v_i^2)$
$535,51$✓$= ½\ (70)(v_f^2 - 4)$ ✓
$v_f = 4,39\ m\cdot s^{-1}$✓

[12.2.3] (4)
[16]

QUESTION 6

6.1 Doppler effect ✓ [12.2.1] (1)

6.2 Towards ✓ [12.2.2] (1)

6.3 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓ / $f_L = \frac{v}{v - v_s} f_s$

$\therefore$ 2 080 ✓= $(\frac{340 \pm 0}{340 - v_s})$ 2 000 ✓

$\therefore v_s$ = 13,08 m·s^{-1} ✓ [12.2.3] (4)

$v_L = \frac{v + v_L}{v - v_s} f_s$ / $v_L = \frac{v - v_L}{v - v_s} f_s$ Max. $\frac{3}{4}$

6.4 Equal to (2 000 Hz) ✓
The passenger moves at the same velocity as the train. / There is no difference in velocity of the passenger relative to the train. ✓ [12.2.2] (2)
[8]

QUESTION 7

7.1 The ability of a wave to bend / spread out (in wave fronts). ✓
as they pass through a small aperture / around a sharp edge. ✓ [12.2.1] (2)

7.2 $\sin\theta = \frac{m\lambda}{a}$ ✓

$\sin 3° \checkmark = \frac{2\lambda}{0{,}02 \times 10^{-3}}$ ✓

$\lambda = \frac{(\sin 3)(0{,}02 \times 10^{-3})}{2}$

= 5,23 x 10^{-7} m ✓ (523 nm) [12.2.3] (4)

7.3 Green ✓
It has a shorter wavelength than yellow light. ✓

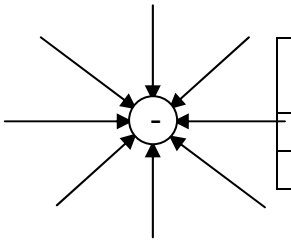
OR
λ(yellow) > 5,23 x 10^{-7} m / 523 nm [12.2.2] (2)

7.4 Increase the slit width. ✓
Decrease the distance between the screen and the slit. ✓ [12.1.1] (2)

7.5 A central band of alternate bright and dark bands ✓of equal width. ✓ [12.1.4] (2)
[12]

QUESTION 8

8.1



Checklist: Criteria for electric field	Marks
Direction of field (towards charge)	✓
Shape (Field radially symmetrical)	✓

[12.1.2] (2)

8.2 $n_{electrons} = \frac{Q}{q_e}$

$= \frac{-4\times10^{-9}}{-1,6\times10^{-19}}$ ✓OR $\frac{4\times10^{-9}}{1,6\times10^{-19}}$

$= 2,5 \times 10^{10}$ ✓ (electrons)

[12.2.3] (2)

8.3 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^{9})(4\times10^{-9})(2\times10^{-9})}{(1\times10^{-2})^2}$ ✓✓

$= 7,2 \times 10^{-4}$ N✓

OR

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$= \frac{(9\times10^{9})(-4\times10^{-9})(+2\times10^{-9})}{(1\times10^{-2})^2}$ ✓✓

$= -7,2 \times 10^{-4}$ N

$= 7,2 \times 10^{-4}$ N ✓

[12.2.3] (4)

8.4

New charge $= \frac{(-4\times10^{-9})+(2\times10^{-9})}{2}$ ✓

$= -1 \times 10^{-9}$ C ✓

$U = \frac{kQ_1Q_2}{r}$ ✓

$= \frac{(9\times10^{9})(-1\times10^{-9})(-1\times10^{-9})}{(1\times10^{-2})}$ ✓✓

$= 9 \times 10^{-7}$ J ✓

[12.1.3] (6)
[14]

QUESTION 9

9.1
$$R = \frac{V}{I} \checkmark$$
$$= \frac{12}{1,2} \checkmark$$
$$= 10\ \Omega \checkmark$$
[12.2.3] (3)

9.2 $R_{total} = R + r$ ✓
$10 \checkmark = (6 + 3,6) \checkmark + r$
$r = 0,4\ \Omega$ ✓
[12.2.3] (4)

9.3 $W = I^2Rt$ ✓
$= (1,2)^2(6)(180)$ ✓ OR $(1,2)^2(6)(3 \times 60)$
$= 1\ 555,2$ J ✓/$1,56 \times 10^3$ J
[12.2.3] (3)

9.4 9.4.1 Decreases ✓ (or any equivalent word) [12.2.2] (1)

9.4.2 Increases ✓ (or any equivalent word) [12.2.2] (1)

9.5 Increases ✓
R_{ext} decreases ✓ (significantly).
I through battery increases ✓ (significantly).

<u>$W = I^2rt$</u>/ Energy transfer to the battery / work done by battery <u>increases</u> (substantial). ✓

OR

$W = \frac{V^2}{r}t$ / Energy transfer to the battery / work done by battery <u>increases</u> (substantial).
[12.1.3] (4)
[16]

QUESTION 10

10.1 AC generator – slip rings✓
DC generator – (split ring) commutator✓ (2)

IF: The one has a slip ring and the other one has a (split ring) commutator. $\frac{1}{2}$ [12.2.1]

10.2 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓ = $\frac{6,43}{\sqrt{2}}$ ✓ = 4,55 A✓ [12.2.3] (3)

10.3 $I_{rms} = \frac{V_{rms}}{R}$ ✓

$\therefore 4,55 = \frac{V_{rms}}{48,4}$ ✓

V_{rms}= 220,22 V

$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$220,22 = \frac{V_{max}}{\sqrt{2}}$ ✓

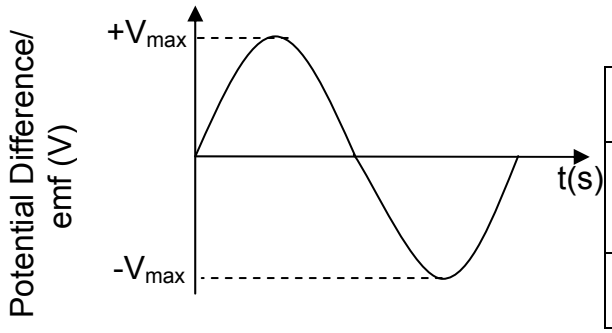
V_{max} = 311,44 V ✓

OR

$V_{max} = I_{max}R$✓✓
= (6,43) ✓ (48,4) ✓
= 311,21 V✓

[12.1.3] (5)

10.4



Checklist Criteria for Graph	Marks
V_{max} correctly shown : $-V_{max}$ and $+V_{max}$/-311,44 V and =311,44 V	✓
Correct shape for at least one complete cycle.	✓

[12.1.2] (2)

10.5 Less air pollution ✓ [12.3.2] (1)

[13]

QUESTION 11

11.1 11.1.2

Checklist Criteria for investigative question	Mark
The dependent and independent variables are stated.	✓
Asks a question about the relationship between the dependent and independent variable.	✓

Examples:
Which <u>type of radiation</u> will <u>emit (photo)electrons</u> from zinc?
OR
Which one of <u>red light or ultraviolet light</u> will <u>emit (photo) electrons</u> from zinc? [12.1.1] (2)

11.1.2 <u>Ultraviolet light emits photoelectrons</u> (from the zinc plate). ✓
<u>Electrons in the gold leaves move upward</u> (into the disc of the electroscope due to the shortage of electrons). ✓
<u>Less negative charges in gold leaves</u>. / less repulsion between the gold leaves. ✓ [12.1.4] (3)

11.1.3 Only ultra violet light/radiation will eject (photo) electrons (from the surface of zinc). ✓✓
OR
Red light does not eject (photo) electrons from zinc. ✓✓ [12.1.2] (2)

11.1.4 Any ONE
It causes damage to the skin / skin cancer.✓
It cause damage to the eye / cataracts. [12.3.2] (1)

11.2 11.2.1 The <u>minimum energy needed</u> ✓by an electron (in a metal) to be <u>emitted from the metal's surface</u>. ✓ [12.2.1] (2)

11.2.2 X-rays ✓
OR
Gamma-rays [12.2.1] (1)

11.2.3

<u>OPTION 1</u>
$E = hf$ ✓
$= (6{,}63 \times 10^{-34})(4{,}29 \times 10^{14})$ ✓
$= 2{,}84 \times 10^{-19}$ J ✓
$E < W_o$ ✓ - no electrons are emitted.

<u>OPTION 2</u>
$hf = W_0 + \frac{1}{2}mv^2$ ✓
$(6{,}63 \times 10^{-34})(4{,}29 \times 10^{14}) = 6{,}88 \times 10^{-19} + ½\ mv^2$ ✓
$½\ mv^2 = -4{,}04 \times 10^{-19}$ J ✓
Kinetic energy of photo-electrons < 0 ✓ ∴ no electrons are emitted

[12.2.3] (4)
[15]

TOTAL SECTION B: 125
GRAND TOTAL: 150