SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE

SUID-AFRIKAANSE KOMPREHENSIEWE ASSESSERINGSINSTITUUT

PHYSICAL SCIENCES

2021

GRADE 12 PRELIMINARY EXAMINATION

PAPER 1

MEMORANDUM

TOTAL: 150

TIME: 3 hours

This memorandum consists of 16 pages.

PHYSICAL SCIENCES

PAPER 1

TOTAL: 150

TIME: 3 HOURS

INSTRUCTIONS EN INFORMATION

1. Marks will be awarded for: correct formula, correct substitution, and correct answer with unit.
2. No marks will be awarded if an incorrect or inappropriate formula is used, even though there may be relevant symbols and applicable substitutions.
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
4. If no formula is given, but all substitutions are correct, the candidate will forfeit one mark.
5. No penalisation if zero substitutions are omitted in calculations where correct formula/principle is given correctly.
6. Mathematical manipulations and change of subject of appropriate formulae carry no marks, but if a candidate starts off with the correct formula and then changes the subject of the formula incorrectly, marks will be awarded for the formula and the correct substitutions. The mark for the incorrect numerical answer is forfeited.
7. Marks are only awarded for a formula if a calculation has been attempted, i.e. substitutions have been made or a numerical answer given.
8. Final answers to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.
9. 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.
10. Questions in which a series of calculations have to be made do not necessarily always have to follow the same order.
11. Candidates will only be penalised once for the repeated use of an incorrect unit within a question.
12. Units are only required in the final answer to a calculation.
13. Marks are only awarded for an answer, and not for a unit per se. The mark for the final answer is only awarded if the answer AND unit are correct. If one of the two is incorrect or omitted, the mark may not be awarded.
14. SI units must be used.
15. If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct.
16. Positive marking will be indicated where relevant.

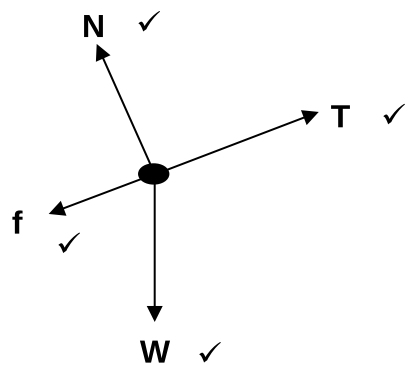
QUESTION 1

1.1	C	✓✓	(2)
1.2	C	✓✓	(2)
1.3	D	✓✓	(2)
1.4	D	✓✓	(2)
1.5	D	✓✓	(2)
1.6	C	✓✓	(2)
1.7	C	✓✓	(2)
1.8	A	✓✓	(2)
1.9	A	✓✓	(2)
1.10	B	✓✓	(2)
			[20]

QUESTION 2

2.1.1 When a resultant/net force acts on an object, the object will accelerate in the direction of the force at acceleration directly proportional to the force and inversely proportional to the mass of the object. ✓✓ (2)

2.2



Accept the following symbols	
N	F_N / Normal / Normal force
f	F_f / F_k / Frictional force / Kinetic frictional force
W	F_g / mg / Weight / $F_{earth\ on\ block}$ / Gravitational force
T	Tension / F_T / F

Marking notes

- Mark is allocated for label and arrow.
- Don't penalise the length of the arrows.
- Subtract 1 mark for any additional force. .
- If forces don't make contact with the object (dot): max 3/4
- If arrows are omitted: max ¾
- If the weight/gravitational force (W) is broken up into its components, the mark is still given as long as the components are drawn correctly.

(4)

2.3 $f_k = \mu_k N$ ✓

$f_k = \mu_k.mg\cos\theta$

$f_k = (0,24) \times (8)(9,8)\cos 40^\circ$ ✓

$f_k = 14,41$ N ✓ (3)

2.4 Positive marking from question 2.3

For block P

$F_{net} = ma$ ✓

$T - f_k - W_{\parallel} = ma$

$T - f_k - mg\sin\theta = ma$

Positive marking from question 2.3

$T - 14,41 - (8)(9,8)\sin 40^{\circ} = 8a$ ✓

$T - 14,41 - 50,39 = 8a$

$T - 64,8 = 8a$

$T = 8a + 64,8$ ……….(1)

For block Q

$F_{net} = ma$

$W - T = ma$

$mg - T = ma$

$(12)(9,8) - T = 12a$ ✓

$117,6 - T = 12a$

$117,6 - 12a = T$ ……….(2)

$8a + 64,8 = 117,6 - 12a$ ✓

$20a = 52,8$

$a = 2,64\ m.s^{-2}$ ✓

Substitute back into (1)

$T = 8(2,64) + 64,8$ ✓

$T = 85,92\ N$ ✓

OR

Substitute back into (2)

$117,6 - 12(2,64) = T$ ✓

$T = 85,92\ N$ ✓

(7)

[16]

QUESTION 3

3.1 A projectile is an object upon which the only force acting is the force of gravity.✓✓(2)

3.2 -9,8 $m.s^{-2}$ ✓✓ **or** 9,8 $m.s^{-2}$ downwards ✓✓

Note: The minus in front of 9,8 $m.s^{-2}$ may not be omitted, unless the direction is given.

Make sure candidates write $m.s^{\mathbf{-2}}$ and not $m.s^{\mathbf{-1}}$. (2)

3.3 Area under the graph = ½ b. ⊥ h ✓

= ½ (0,5) (4,9) ✓

= 1,225 m ✓

Note: As stated in the question, equations of motion may NOT be used to calculate this answer (3)

3.4 **Option 1**

$\Delta y = \left(\frac{v_i+v_f}{2}\right)\Delta t$ ✓

$\Delta y = \left(\frac{-4,9+(-20,4)}{2}\right)(1,58)$ ✓ ✓

$\Delta y = 19,99\ m$ ✓

Option 2

$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

$\Delta y = (-4,9)(1,58) + \frac{1}{2}(-9,8)(1,58)^2$ ✓ ✓

$\Delta y = 19,97\ m$ ✓

Option 3

$vf^2 = vi^2 + 2a\Delta y$ ✓

✓ $(-20,4)^2 = (-4,9)^2 + 2(-9,8)\Delta y$ ✓

$\Delta y = 20,1\ m$ ✓

Option 4

Area under the graph = ½ b. ⊥ h ✓

Area under the graph = ½ (2,08)(20,4) ✓

Area under the graph =21,216 m

21,216 m – 1,225 m (max height) ✓

=19,99 m ✓

Option 5

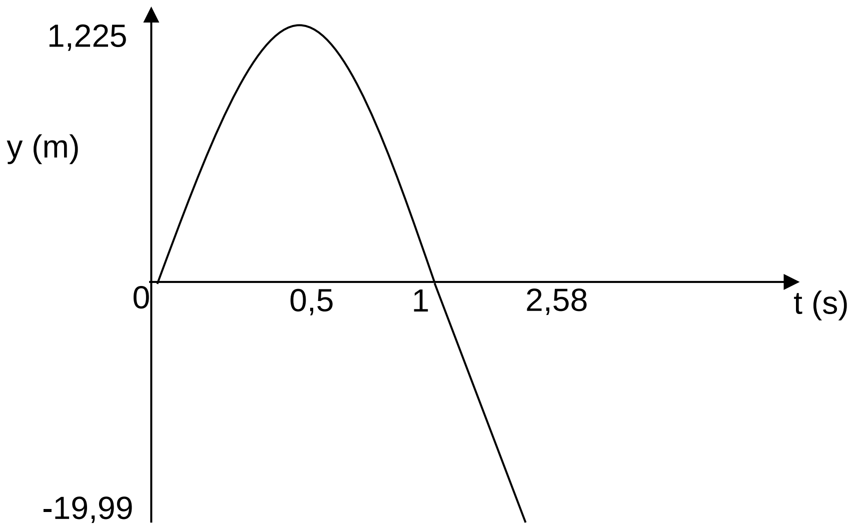
$\Delta y = \frac{(v_i+v_f)}{2}\Delta t$ ✓

$\Delta y = \frac{(4,9+(-20,4))}{2}(2,58)$ ✓ ✓

$\Delta y = 19,99\ m$ ✓

(4)

3.5



Marking of position-time graph	
Correct shape of graph	✓
Maximum height and time 0,5 s correctly indicated	✓
Height of building and total time indicated	✓

(3)
[14]

QUESTION 4

4.1 The total linear momentum of a closed system remains constant (is conserved)✓✓ (2)

4.2

$$\sum p \text{ before} = \sum p \text{ after}$$

$$mv_{i\ Amelia} + mv_{i\ Juan\text{-}Pierre} = (m_{Amelia} + m_{Juan\text{-}Pierre})v_f$$ ✓

$$(53)(-5) + (68)(7) = (53 + 68)v_f$$ ✓ ✓

$$211 = 121v_f$$

$v_f = 1{,}74\ m.s^{-1}$ ✓ forward or right (indicated on illustration) ✓

(5)

4.3 4.3.1 Decrease ✓ (1)

4.3.2 According to the impulse-momentum theorem, the <u>net force</u> acting on an object (in this case Amelia) is <u>inversely proportional to the contact time</u> ✓ $F_{net} \propto \frac{1}{\Delta t}$ <u>As Amelia bends her knees,</u> she prolongs the contact time between herself and the ground, and the <u>force exerted on her, is smaller</u>. ✓ (2)

[10]

QUESTION 5

5.1.1 A *non-conservative force* is a force for which the work done in moving an object between two points depends on the path taken. ✓✓ (2)

5.2 W = FΔxcosθ ✓

W = (250)(5)cos0° ✓

W = 1250 J ✓ (3)

5.3 Positive marking from question 5.2

$P = \frac{W}{\Delta t}$ ✓

$P = \frac{1250}{1,3}$ ✓

$P = 961,54\ J.s^{-1}$ ✓ (3)

5.4 **Option 1**

$W_{net} = \Delta E_k$ ✓

$W_W + W_f = \frac{1}{2}mvf^2 - \frac{1}{2}mvi^2$

$W_W + W_f = \frac{1}{2}mvf^2 - \frac{1}{2}mvi^2$

✓ $117,6 + W_f = \frac{1}{2}(4)(9)^2 - \frac{1}{2}(4)(0)^2$ ✓

$117,6 + W_f = 162 - 0$

$W_f = 44,4\ J$ ✓

$W_W = -\Delta E_p$

$W_W = -(mgh_f - mgh_i)$

$W_W = -[(4)(9,8)(0) - (4)(9,8)(3)]$ ✓

$W_W = -[0 - 117,6]$

$W_W = 117,6\ J$

Option 2

$W_{nc} = \Delta E_k + \Delta E_p$ ✓

$W_f = \left[\frac{1}{2}mvf^2 - \frac{1}{2}mvi^2\right] + [mgh_f - mgh_i]$

✓ $W_f = \left[\frac{1}{2}(4)(9)^2 - \frac{1}{2}(4)(0)^2\right] + [(4)(9,8)(0) - (4)(9,8)(3)]$ ✓ ✓

$W_f = [162] + [-117,6]$

$W_f = 44,4\ J$ ✓ (5)

[13]

QUESTION 6

6.1 The Doppler-effect is the <u>change in frequency</u> (or pitch) of the sound <u>detected by a listener</u> because the sound source and the listener have <u>different velocities</u> relative to the medium of sound propagation. ✓✓ (2)

6.2 v = f λ ✓
340 = f (0,34) ✓
f = 1000 Hz ✓ (3)

6.3 Positive marking from question 6.2

$f_L = \frac{v \pm v_L}{v \pm v_B} f_B$

$f_L = \frac{v}{v - v_B} f_B$ } ✓

$f_L = \frac{340}{340-11}$ ✓ (1000) ✓

$f_L = 1033,4$ ✓ Hz ✓ (5)

6.4 Decrease ✓ (1)

6.5 The speed of blood can be measured using a Doppler flow meter. ✓
A foetus in the uterus can be monitored. ✓
A Doppler radar is used by weather stations to detect precipitation. ✓
Radar meters are used to determine the speed of moving objects (e.g. by traffic officers) ✓
Any **ONE** correct answer. (1)

6.6 6.6.1 Towards star A. ✓
If star A's double line is used as a reference, it is clear that star B's double line <u>moved to the blue side</u> of the absorption spectrum. ✓ (2)

6.6.2 Blue shifts ✓ (1)

[15]

QUESTION 7

7.1 $\frac{(+2 \times 10^{-6}) + (-8 \times 10^{-5})}{2}$ ✓

$= -3{,}9 \times 10^{-5}$ C ✓ (2)

7.2 The magnitude of the electrostatic force exerted by one point charge (Q1) on another point charge (Q2) is directly proportional to the product of the magnitudes of the charges and inversely proportional to the square of the distance (r) between them. ✓✓ (2)

7.3 Positive marking from question 7.1

$F_{AC} = \frac{kQ1Q2}{r^2}$ ✓

$F_{AC} = \frac{(9\times10^{9})(3{,}9 \times 10^{-5})(4{,}2 \times10^{-5})}{(0{,}25)^2}$ ✓

$F_{AC} = 235{,}87\ N\ upwards$

$F_{BC} = \frac{kQ1Q2}{r^2}$

$F_{BC} = \frac{(9\times10^{9})(3{,}9 \times 10^{-5})(4{,}2 \times10^{-5})}{(0{,}35)^2}$ ✓

$F_{BC} = 120{,}34\ N\ right$

$Fnet^2 = F_{AC}2 + F_{BC}2$

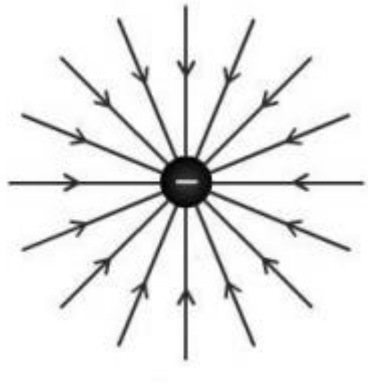
$F_{net} = \sqrt{F_{AC}2 + F_{BC}2}$ ✓

Show FAC and FBC

$F_{net} = \sqrt{(235{,}87)^2 + (120{,}34)^2}$

$F_{net} = 264{,}79\ N$ ✓ (5)

7.4



Criteria for the drawing of electrical field lines around sphere P	
Direction	✓
Field lines radial inwards	✓

(2)

7.5 $E_{SP} = \frac{kQ}{r^2}$ ✓

$E_{SP} = \frac{(9 \times 10^9)(0,7 \times 10^{-6})}{0,11^2}$ ✓

$E_{SP} = 5,2 \times 10^5$ N.C^{-1} to the left

$E_{SQ} = \frac{kQ}{r^2}$

$E_{SQ} = \frac{(9 \times 10^9)(0,9 \times 10^{-6})}{0,07^2}$ ✓

$E_{SP} = 1,65 \times 10^6$ N.C^{-1} to the left

$E_{net} = E_{SP} + E_{SQ}$

$E_{net} = (5,2 \times 10^5) + (1,65 \times 10^6)$ ✓

$E_{net} = 2,17 \times 10^6$ N.C^{-1} ✓ (5)

[16]

QUESTION 8

8.1 The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. ✓✓ (2)

8.2 As the current in the circuit increases, the potential difference will also increase. ✓✓

OR

As the current in the circuit increases, the potential difference will also decrease.✓✓

OR

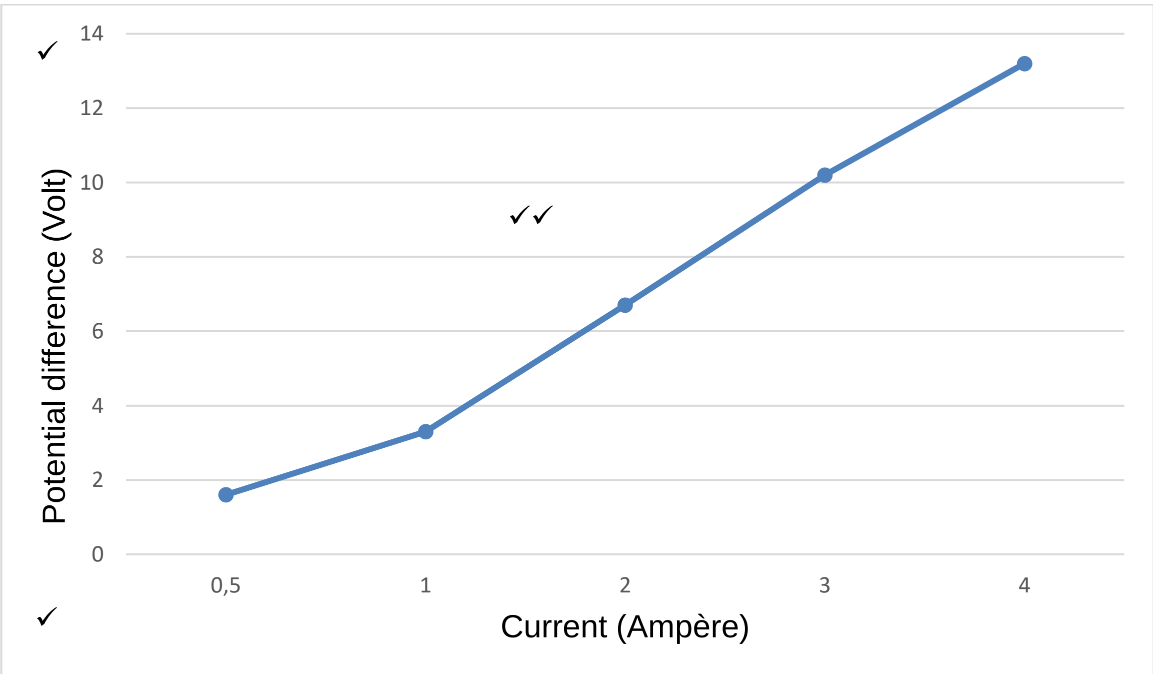
As the current in the circuit increases, the potential difference will remain unchanged. ✓✓ (2)

8.3 8.3.1 Potential difference (Volt) ✓ (1)

8.3.2 Current (Ampère) ✓ (1)

8.3.3 Temperature ✓ (1)

8.4 **Graph that shows the change in potential difference as current is increased.**



Criteria for marking of the graph	
Both axes labelled correctly (with units)	✓
Correct scale used (with equal intervals)	✓
All points plotted correctly	✓
Connect with a straight line of best fit	✓

(4)

8.5 The learners could have added an extra resistor in parallel with each repetition of the experiment.✓ More resistors in parallel, leads to a lower external resistance in the circuit ✓ and a lower resistance leads to a higher current ✓ If there is a decrease in the total external resistance (because of more resistors in parallel), there will be an increase in current. (3)

8.6 $R_p = \frac{R_1 R_2}{R_{1+} R_2}$

$R_p = \frac{(4)(2)}{4+2}$ ✓

$R_p = 1{,}33\ \Omega$

$R_{TOT} = R_p + R_S$

$R_{TOT} = 1{,}33 + 7$ ✓

$R_{TOT} = 8{,}33\ \Omega$ ✓

$I = \frac{\varepsilon}{R_{ekst} + r}$ ✓

$I = \frac{12}{8{,}33+1}$ ✓

$I = 1{,}29\ A$ ✓ (6)

[20]

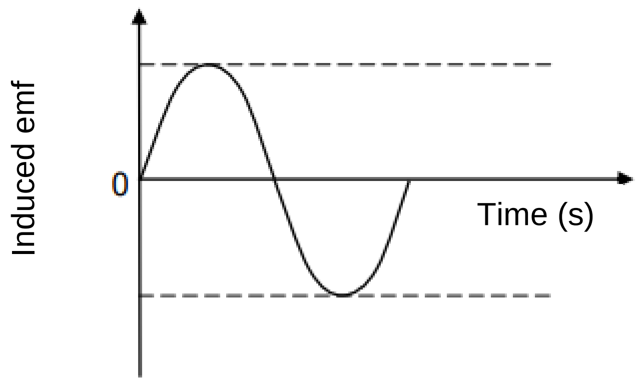
QUESTION 9

9.1 An alternating current generator ✓

An alternating current generator has two slip rings (as shown in the diagram) while a direct current generator has just one commutator. ✓ (2)

9.2 Mechanical energy ✓ to electrical energy ✓ (2)

9.3



✓✓

(2)

9.4 $P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$P_{ave} = \frac{220^2}{35,6}$ ✓ ✓

$P_{ave} = 1359,55\ W$ ✓ (4)

9.5 Positive marking from question 9.4

$P_{ave} = V_{rms}I_{rms}$

$1359,55 = (220)I_{rms}$ ✓

$I_{rms} = 6,18\ A$

OR

$P_{ave} = I_{rms}{}^2R$

$1359,55 = I_{rms}{}^2(35,6)$ ✓

$I_{rms} = 6,18\ A$

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$

$6,18 = \frac{I_{max}}{\sqrt{2}}$ ✓

$I_{max} = 8,74\ A$ ✓ (3)

[13]

QUESTION 10

10.1 Threshold frequency is the minimum frequency of light needed to emit electrons from a certain metal surface. ✓✓ (2)

10.2 $E = hf$

$(3{,}72 \times 10^{-19}) = (6{,}63 \times 10^{-34})f$ ✓

$f = 5{,}61\ x\ 10^{14}\ Hz$ ✓

This photon belongs to <u>green</u> light. ✓ (3)

10.3 $W_o = hf_0$ ✓

$(3{,}32\ x\ 10^{-19}) = (6{,}63\ x\ 10^{-34})f_0$ ✓

$f_o = 5{,}0\ x\ 10^{14}\ Hz$ ✓

<u>Red</u> light will not emit electrons from the surface of this metal. ✓ (4)

10.4 It will have no effect on the emission of electrons from the caesium. A change in the light's intensity, does not change the light's frequency. The red light's photons still do not have enough energy to overcome the work function of the caesium. ✓ (1)

10.5 $E = W_o + E_{k\,(max)}$ ✓

$hf = W_o + E_{k\,(max)}$

$(6{,}63 \times 10^{-34})(1{,}1 \times 10^{15}) = (3{,}32 \times 10^{-19}) + E_{k\,(max)}$ ✓

$E_{k\,(max)} = 3{,}97 \times 10^{-19} J$ ✓ (3)

[13]

GRAND TOTAL: [150]