KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

MARKING GUIDELINE

PREPARATORY EXAMINATION

SEPTEMBER 2022

MARKS: 150

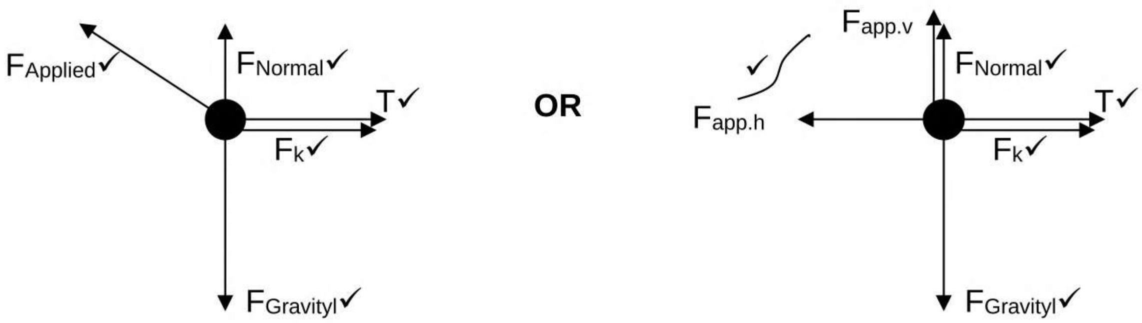
This marking guideline consists of 15 pages.

QUESTION 1

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

QUESTION 2

2.1



Accept the following symbols	
F_{Normal}	N; Normal
$F_{Applied}$	45,0N/F/F_A/F_{app}
T	$F_{TENSION}$/Tensional force
F_k	f_s/f/friction/F_r
W	F_g/mg/98N

If components of F_{app} and F_{app} shown then minus one mark.

Notes

- Mark is awarded for label and arrow.
- Do not penalise for length of arrows.
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with body/dot: *Max:4/*5
- If arrows missing but labels are there: *Max:4/*5

(5)

2.2 Normal is the force or the component of a force which a surface exerts on an object with which it is in contact, and which is perpendicular to the surface. ✓✓ (2)

NOTE:

If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.

2.3 $F_{net} = ma$ ✓
$F_v + N - F_g = 0$
$45\sin30^o + N - 10(9,8)$ ✓ $= 0$✓
$N = 75,50$ N✓ (4)

2.4 **POSITIVE MARKING FROM QUESTION 2.3**

<u>OPTION 1</u>

CONSIDER 10 kg BLOCK
TAKING LEFT TO BE POSITIVE

$F_{net} = ma$ } ✓
$F_H - T - F_{fk} = ma$
$45\cos 30^o$✓ $- T -$ <u>$0{,}125(75{,}50)$</u> ✓ $= 10(2{,}5)$✓

$T = 4{,}53$ N

CONSIDER BLOCK m

$F_{net} = ma$
$T - F_{fk} = m(2{,}5)$
<u>$4{,}53 - 1$</u>✓ $= m(2{,}5)$
$m = 1{,}41$ kg✓

<u>OPTION 2</u>

CONSIDER 10 kg BLOCK
TAKING LEFT TO BE NEGATIVE

$F_{net} = ma$ } ✓
$-F_H + T + F_{fk} = ma$
$-45\cos 30^o$✓ $+ T +$ <u>$0{,}125(75{,}50)$</u> ✓ $= -10(2{,}5)$✓
$T = -4{,}53$ N

CONSIDER BLOCK m

$F_{net} = ma$
$T - F_{fk} = m(2{,}5)$
<u>$-4{,}53+1$</u>✓ $= m(-2{,}5)$
$m = 1{,}41$ kg✓

<u>OPTION 3</u>

If masses added then max 3/6

- $F_{net} = ma$ ✓
- $45\cos 30^o$ ✓
- $1{,}41$ kg ✓ (6)

[17]

QUESTION 3

3.1 $9{,}8\ m\cdot s^{-2}$ ✓ downwards ✓ (2)

3.2.1

(downward positive)	(upwards positive)
$v_f = v_i + a\Delta t$ ✓ $0 = (-20) + 9{,}8\Delta t$ ✓ $\Delta t = 2{,}04\ s$ ✓	$v_f = v_i + a\Delta t$ ✓ $0 = 20 + (-9{,}8)\Delta t$ ✓ $\Delta t = 2{,}04\ s$ ✓

(3)

3.2.2 **OPTION 1**

(downward positive)	(upwards positive)
$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (-20)^2 + 2 \times (9{,}8)(-8)$ ✓ $v_f = 15{,}60\ m\cdot s^{-1}$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = (20)^2 + 2 \times (-9{,}8)(8)$ ✓ $v_f = 15{,}60\ m\cdot s^{-1}$ ✓

OPTION 2

Considering motion from maximum height

(downward positive)	(upwards positive)
$v_f^2 = v_i^2 + 2a\Delta y$ $0 = 20^2 + 2(9{,}8)\ \Delta y$ $\Delta y = 20{,}41\ m$	$v_f^2 = v_i^2 + 2a\Delta y$ $0 = 20^2 + 2(-9{,}8)\ \Delta y$ $\Delta y = 20{,}41\ m$

On its way down $\Delta y = 20{,}41 - 8 = 12{,}41\ m$

$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(9{,}8)(12{,}41)$ ✓ $v_f = 15{,}60\ m\cdot s^{-1}$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓ $v_f^2 = 0 + 2(-9{,}8)(-12{,}41)$ ✓ $v_f = 15{,}60\ m\cdot s^{-1}$ ✓

OPTION 3

Considering motion from ground to the roof

(downward positive)	(upwards positive)
$\Delta y = v_i\ \Delta t + ½\ a\Delta t^2$ $8 = 20\ \Delta t + ½\ (-9{,}8)\Delta t^2$ $\Delta t = 0{,}45 s$ $v_f = v_i + a\Delta t$ ✓ $v_f = (-20) + 9{,}8(0{,}45)$ ✓ $v_f = 15{,}60\ m\cdot s^{-1}$ ✓	$\Delta y = v_i\ \Delta t + ½\ a\Delta t^2$ $-8 = -\ 20\ \Delta t + ½\ (9{,}8)\Delta t^2$ $\Delta t = 0{,}45 s$ $v_f = v_i + a\Delta t$ ✓ $v_f = (-20) + 9{,}8(0{,}45)$ ✓ $v_f = 15{,}60\ m\cdot s^{-1}$ ✓

(3)

3.2.3 **OPTION 1**

(downward positive)	**(upwards positive)**
$\Delta y = v_i \Delta t + ½ a\Delta t^2$ ✓ -8 ✓ = $\underline{-20 \Delta t + ½ (9,8)(\Delta t)^2}$ ✓ Δt = 3,63s or Δt = 0,45s Δt = 3,63s ✓	$\Delta y = v_i \Delta t + ½ a\Delta t^2$ ✓ 8 ✓= $\underline{20 \Delta t + ½ (-9,8) (\Delta t)^2}$✓ Δt = 3,63s or Δt = 0,45s Δt = 3,63s ✓

OPTION 2:

POSITIVE MARKING FROM QUESTION 3.2.2

(downward positive)	**(upwards positive)**
Time taken to reach maximum height from the ground. $v_f = v_i + a\Delta t$ ✓ $\underline{0 = (-20) + 9,8\Delta t}$ ✓ Δt = 2,04 s From the maximum height to the top of the building $v_f = v_i + a\Delta t$ $\underline{15,60 = 0 + 9,8\Delta t}$✓ Δt = 1,59 s The total time from the ground to the top of the building: Δt_{total} = 2,04 +1,59 = 3,63 s ✓	Time taken to reach maximum height from the ground. $v_f = v_i + a\Delta t$ ✓ $\underline{0 = 20 + (-9,8)\Delta t}$✓ Δt = 2,04 s From the maximum height to the top of the building $v_f = v_i + a\Delta t$ $\underline{-15,60 = 0 - 9,8\Delta t}$✓ Δt = 1,59 s The total time from the ground to the top of the building: Δt_{total} = 2,04 +1,59 = 3,63 s ✓

OPTION 3:

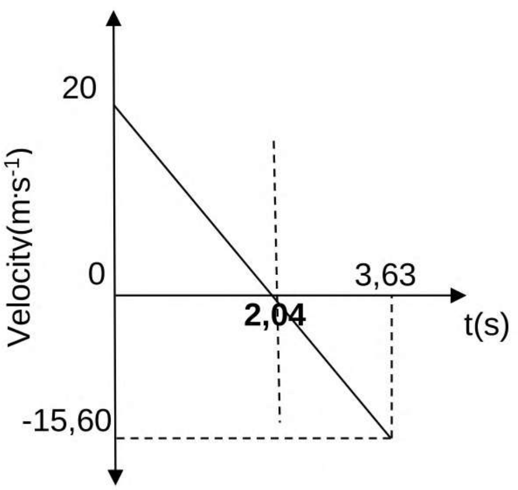
POSITIVE MARKING FROM QUESTION 3.2.2

(downward positive)	**(upwards positive)**
$v_f = v_i + a\Delta t$ ✓ $\underline{15,60}$✓ = $\underline{-20 + 9,8\Delta t}$ ✓ Δt = 3,63 s ✓	$v_f = v_i + a\Delta t$ ✓ $\underline{-15,60}$✓ = $\underline{20 + (-9,8)\Delta t}$ ✓ Δt = 3,63 s ✓

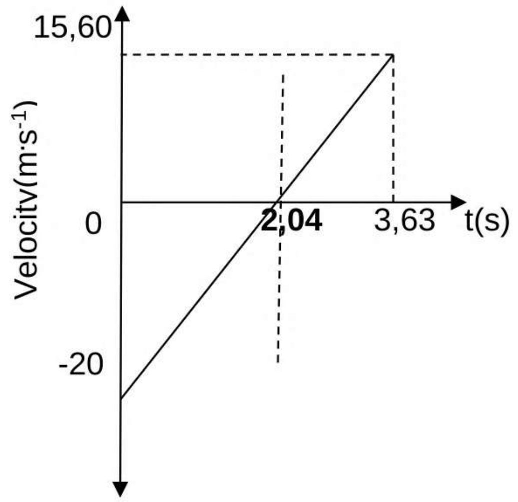
(4)

3.3 POSITIVE MARKING FROM QUESTION 3.2.1 AND 3.2.2

(upwards positive)



(downward positive)



Criteria for marking the graph	Marks
Correct shape (straight line) having a positive and negative velocities with line longer before 2,04 s than after 2,04 s	✓
Graph starts at v = 20 $m\cdot s^{-1}$/-20 $m\cdot s^{-1}$ and t = 0 s	✓
Graph cuts t-axis at 2,04 s at v = 0 m·s-1	✓
Graph shows the v = -15,60$m\cdot s^{-1}$/15,60 $m\cdot s^{-1}$at t = 3,63 s	✓

(4)

[16]

QUESTION 4

4.1 The total linear momentum of an isolated system remains constant (is conserved). ✓✓ (2)

4.2 **OPTION 1**

Taking right to be positive

$\Sigma p_i = \Sigma p_f$
$m_A v_{iA} + m_B v_{iB} = m_A v_{fA} + m_B v_{fB}$ ✓
60 (0,60)+85 (0) ✓= 60(-0,20)+85 v_{fB}✓
v_{fB} = 0,57 m·s^{-1} ✓ to the right✓

OPTION 2

Taking left to be positive

$\Sigma p_i = \Sigma p_f$
$m_A v_{iA} + m_B v_{iB} = m_A v_{fA} + m_B v_{fB}$ ✓
60 (-0,60) + 85 (0) ✓ = 60 (0,20) + 85 v_{fB}✓
v_{fB} = - 0,57 m·s^{-1}
v_{fB} = 0,57 m·s^{-1} ✓ to the right✓ (5)

4.3 **POSITIVE MARKING FROM QUESTION 4.2**

$\Sigma K_i = ½ m_A v_{iA}^2 + ½ m_B v_{iB}^2$ ✓ = ½ (60)(0,6)^2 +0✓ = 10,80 J	$\Sigma K_f = ½ m_A v_{fA}^2 + ½ m_B v_{fB}^2$ = ½ (60)(0,2)^2 + ½(85)(0,57)^2✓ = 15,01 J

$\Sigma K_f \neq \Sigma K_i$ ✓ OR Total Ek before ≠ Total Ek after
∴ Collision is Inelastic ✓

NOTE:

If learners starts with $\Sigma K_f = \Sigma K_i$, then minus one mark.

(5)

[12]

QUESTION 5

5.1 The total mechanical energy (sum of gravitational potential energy and kinetic energy) in an isolated system remains constant. ✓✓ (2)

5.2 $E_{MA} = E_{MB}$
$(K + U)_X = (K+U)_Y$ } ✓
$(½ mv^2 + mgh)_X = (½mv^2 + mgh)_Y$
$\underline{(0,5)(2)(0) + (2)(9,8)(5)}$ ✓ = $\underline{0,5(2)v^2 + 0}$✓
$v = 9,90 \text{ m·s}^{-1}$✓ (4)

5.3 <u>The net work done on an object</u> is <u>equal to</u> the <u>change in the object's kinetic energy</u> ✓✓

OR

The <u>work done on an object by a net force</u> is <u>equal to</u> the <u>change in the object's kinetic energy</u>. ✓✓ (2)

> **NOTE:**
>
> If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.

5.4 **<u>OPTION 1</u>**

$W_{net} = \Delta K$✓

$mg\sin 30^\circ\left(\frac{5}{\sin 30^\circ}\right)$ ✓= $\underline{½(2)v^2 - 0}$✓

$v = 9,90 \text{ m·s}^{-1}$✓

<u>OPTION 2</u>

$W_{net} = \Delta K$✓

$mg\cos 300^\circ\left(\frac{5}{\sin 30^\circ}\right)$ ✓= $\underline{½(2)v^2 - 0}$✓

$v = 9,90 \text{ m·s}^{-1}$✓

<u>OPTION 3</u>

$W_{nc} = \Delta E_p + \Delta E_k$ ✓

0✓ = $\underline{2 \times 9,8 (0 – 5) + ½(2)v^2 - 0}$ ✓

$v = 9,90 \text{ m·s}^{-1}$✓

(4)

5.5 Equal ✓
Work done by the conservative force does not depend on the path taken. ✓✓
OR: gravitational force is the only force doing work on the block. It is a conservative force✓✓ (3)

[15]

QUESTION 6

6.1 Doppler effect as the (apparent) change in frequency (or pitch) of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation. ✓✓ (2)

6.2 $v = f\lambda$ ✓

$340 = f(0,80)$ ✓

$f = 425$ Hz ✓ (3)

6.3 **POSITIVE MARKING FROM QUESTION 6.2**

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s \checkmark$$

$$\frac{340 \checkmark}{(340 - v_s) \checkmark} \cdot 400 \checkmark$$

$v_s = 20$ m·s^{-1}

$\therefore v_s = 72$ km·h^{-1}

The car was not exceeding the speed limit. ✓

NOTE:
Statement must be marked in relation to answer.

(5)

6.4 Less than ✓ (1)

6.5 Blood flow meter ✓
Detecting foetal heartbeat ✓ (2)

[13]

QUESTION 7

7.1 The magnitude of the electrostatic force exerted by one point charge (Q_1) on another point charge (Q_2) 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)

NOTE:
If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.

7.2 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$1984 = \frac{kQ^2}{x^2}$ ✓ -----------------------(1)

$124 = \frac{kQ^2}{(x+0,8)^2}$ ✓ -----------------------(2)

x = 0,27 m✓ (4)

7.3 **POSITIVE MARKING FROM QUESTION 7.2**

OPTION 1

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$1984 = \frac{9x10^9 Q^2}{0,27^2}$ ✓

Q = 1,27 x10^{-4} C✓

OPTION 2

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$124 = \frac{9x10^9 Q^2}{(0,27+0,8)^2}$ ✓

Q = 1,26 x 10^{-4} C✓ (3)

7.4.1 The electric field at a point is <u>the electrostatic force</u> experienced <u>per</u> <u>unit positive charge</u> placed at that point. ✓✓ (2)

NOTE: If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.

POSITIVE MARKING FROM QUESTION 7.3

7.4.2 $E = \frac{kQ}{r^2}$ ✓

$E_{1P} = \frac{(9x10^9)(1,26x10^{-4})}{(0,4)^2}$ ✓ = 7087500 $N \cdot C^{-1}$ to the right

$E_{2P} = \frac{(9x10^9)(1,26x10^{-4})}{(0,67)^2}$ ✓ = 2526175,095 $N \cdot C^{-1}$ to the right

$E_{net} = E_{1P} + E_{2P}$
= 7087500 + ✓2526175,095 **NOTE:** The mark is for the addition
= <u>9,61x10⁶ N·C⁻¹ to the right</u> ✓ (5)

7.4.3 **<u>OPTION 1</u>:**

POSITIVE MARKING FROM QUESTION 7.4.2

$E = \frac{F}{q}$ ✓

$9616375,10 = \frac{F}{1,6x10^{-19}}$ ✓

<u>F = 1,54 x 10⁻¹² N to the right</u>✓

<u>OPTION 2</u>:

POSITIVE MARKING FROM QUESTION 7.3

$F = \frac{kQ_1Q_2}{r^2}$

$F_{q1} = \frac{kQ_1q}{r^2}$

$F_{q1} = \frac{k(1,26\,x10^{-4})(1,6\,x10^{-19})}{(0,4)^2}$ ✓

= $1,134 \times 10^{-12}$ N to the right

$F_{q2} = \frac{k(1,26\,x10^{-4})(1,6\,x10^{-19})}{(0,67)^2}$ ✓

= $4,04 \times 10^{-13}$ N to the right

$F_{net} = F_{q1} + F_{q2} = 1,134 \times 10^{-12} + 4,04 \times 10^{-13}$
= <u>1,54 x 10⁻¹² N to the right</u>✓ (3)

[19]

QUESTION 8

8.1.1 *Emf* is the maximum energy provided by a battery per unit charge passing through it. ✓✓ (2)

NOTE:
If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.

8.1.2

EXPERIMENT 2	**EXPERIMENT 1**
$\varepsilon = I(R + r)$ ✓	$\varepsilon = I(R + r)$
$\varepsilon = 20,58 + 1,78r$ ✓------------(1)	$\varepsilon = 18,40 + 6,13r$ ✓ ---------(2)
$r = 0,50\ \Omega$	
$\varepsilon = 20,58 + 1,78(0,5)$ OR	$\varepsilon = 18,40 + 6,13(0,5)$ ✓
$\varepsilon = 21,47\ V$ ✓	

(5)

8.1.3 **POSITIVE MARKING FROM QUESTION 8.1.2**

OPTION 1	**OPTION 2**
EXPERIMENT 2	EXPERIMENT 1
$\varepsilon = I(R + r)$ ✓ $21,47 = 1,78(R+0,5)$ ✓ $R = 11,56\ \Omega$	$\varepsilon = I(R + r)$ ✓ $21,47 = 6,13(R+0,5)$ ✓ $R = 3\ \Omega$
$R_s = R_1 + R_2 + ...$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$
$11,56 = R_1 + R_2$ ✓	$\frac{1}{2,99} = \frac{1}{R} + \frac{1}{R}$ ✓
$R = 5,78\ \Omega$ ✓	$R = 6\ \Omega$ ✓
OPTION 3	**OPTION 4**
$V = IRext$ ✓ $20,58 = 1,78.2R$ ✓ $R = 5,78\ \Omega$ ✓	$V = IRext$ ✓ $18,40 = 6,13\ R/2$ ✓ $R = 6\ \Omega$ ✓

(3)

8.1.4 Decrease ✓
If R_1 is removed in circuit X, the total resistance will increase ✓. For a constant emf ✓, from $P = V^2/R$ ✓, power will decrease. (4)

8.2 **OPTION 1**

$$KWh = \frac{P\Delta t}{1000}$$
$$= \frac{I^2 R\Delta t}{1000}$$
$$= \frac{(4,4^2)(50)(6)}{1000} \checkmark$$
$$= 5,808 \text{ units}$$

Cost of electricity = 1,69 x 5,808 ✓
= R9,82✓

OPTION 2

V = IR
=4,4 x 50
=220 V

$$KWh = \frac{P\Delta t}{1000}$$
$$= \frac{(\frac{V^2}{R})\Delta t}{1000}$$
$$= \frac{(\frac{220^2}{50})6}{1000} \checkmark$$
$$= 5,808 \text{ units}$$

Cost of electricity = 1,69 x 5,808 ✓
= R9,82✓

OPTION 3

$$KWh = \frac{P\Delta t}{1000}$$
$$= \frac{VI\Delta t}{1000}$$
$$= \frac{(220)(4,4)(6)}{1000} \checkmark$$
$$=5,808 \text{ units}$$

Cost of electricity = 1,69 x 5,808 ✓
= R9,82✓ (3)

[17]

QUESTION 9

9.1.1 Split rings (commutator)✓ (1)

9.1.2 Anticlockwise✓✓ (2)

9.1.3 Electrical to mechanical✓✓ (2)

9.2.1 ANY TWO
The DC power supply can replaced by a load / resistor. ✓
The split rings (commutator) is replaced by the slip rings. ✓
The coil should be rotated. (2)

9.2.2
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓

$V_{rms} = \frac{311,13}{\sqrt{2}}$ ✓

Vrms = 220 V✓ (3)

[10]

QUESTION 10

10.1 Work function is the minimum energy that an electron in the metal needs to be emitted from the metal surface. ✓✓ (2)

10.2
$E = \frac{hc}{\lambda}$ ✓

$E = \frac{(6,63 \times 10^{-34})(3,00 \times 10^{8})}{400 \times 10^{-9}}$ ✓

$E = 4,97 \times 10^{-19}$ J✓

OR ✓

$c = \lambda f$

$3 \times 10^{8} = 400 \times 10^{-9}$ ✓

$f = 7,5 \times 10^{14}$ Hz

$E = hf$

$= 6,6 \times 10^{-34} \cdot 7,5 \times 10^{14}$

$= 4,97 \times 10^{-19}$ J ✓ (3)

10.3 **POSITIVE MARKING FROM QUESTION 10.2**

$E = W_0 + \frac{1}{2}mv_{max}^2$ ✓

$4,97 \times 10^{-19}$ ✓ $= 2,46 \times 10^{-19}$ ✓ $+ \frac{1}{2}(9,11 \times 10^{-31})v_{max}^2$

$v_{(max)} = 742322,57\ m \cdot s^{-1}$ ✓ (4)

10.4 No✓
The work function of platinum is higher than the energy of the photon✓ (2)

[11]

TOTAL: 150