SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2022

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

SUBJECT: PHYSICAL SCIENCES

TERM 01

EDUCATORS GUIDE

PAGE (1 OF 47)

NEWTON MEMO

Question 1
Multiple choice questions

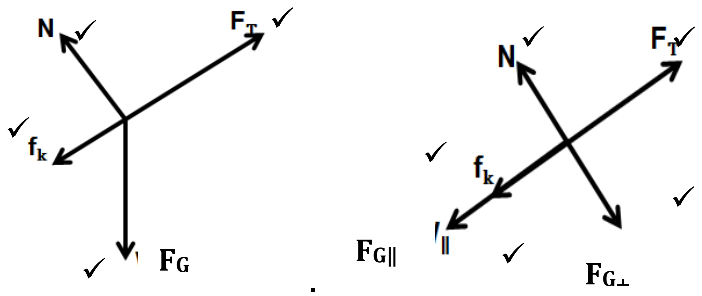
1.1. D ✓✓
1.2. A ✓✓
1.3. A ✓✓
1.4. A ✓✓
1.5. C ✓✓
1.6. B ✓✓
1.7. D ✓✓
1.8. D ✓✓
1.9. B ✓✓
1.10. D ✓✓

$[10 \times 2 = 20]$

Question 2

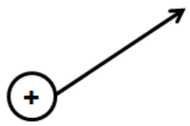
2.1 When a resultant / net force acts on an object, the object will accelerate in the direction of the force. This acceleration is directly proportional to the force ✓ and inversely proportional to the mass of the object. ✓ (2)

2.2 REMAINS THE SAME / BLY DIESELFDE ✓ (1)

2.3


Accepted Labels	
F_G	Weight, gravitational force
f_k	Friction
N	Normal force
F_T	Tension

(4)

2.4


2.4.1. $F_{net} = ma = F_T + f_k + F_{G\parallel}$ ✓

$ma = F_T + \mu_k mgcos30° + mgsin30°$ $\{f_k = \mu_k N\}$ $\{N = -F_{G\perp} = mgcos30°\}$

$(6)(4)$ ✓ $= F_T - (0,2)(6)(9,8)(cos30°)$ ✓ $- (6)(9,8)(sin30°)$ ✓

$\therefore F_T = 63,58\ N$ ✓

(5)

2.4.2. $F + f_{k\ 3kg} + F_{G\parallel} = ma$ ✓

$F - (0,2)(6)(9,8)cos30°$ ✓ $- (0,1)(3)(9,8)cos30°$ ✓ $- (3+6)(9,8)sin30°$ ✓ $= 0$ ✓ $F = 56,83\ N$ ✓

(6)

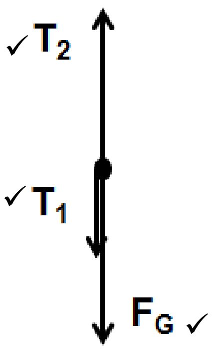
2.5 DECREASES ✓ (1)

[19]

Question 3

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

3.2.



(3)

3.3. $F_{net} = ma$ ✓

<u>5kg</u>

$T_2 + F_G + T_1 = ma$

$250 - (5)(9,8) - T_1$ ✓ $= 5a$ ✓

$201 - T_1 = 5a$

$T_1 = 201 - 5a$ ……..(1)

<u>20kg</u>

$T_1 + F_G = ma$

$T_1 - [(20)(9,8)]$ ✓ $= 20a$

$T_1 = 196 + 20a$ ……..(2)

(1) = (2)

$201 - 5a = 196 + 20a$
$a = 0{,}2\ m \cdot s^{-2}$upwards

$\therefore\ T_1 = 201 - (5)(0{,}2)$ ✓
$\therefore\ T_1 = 200\ N$ ✓
(6)

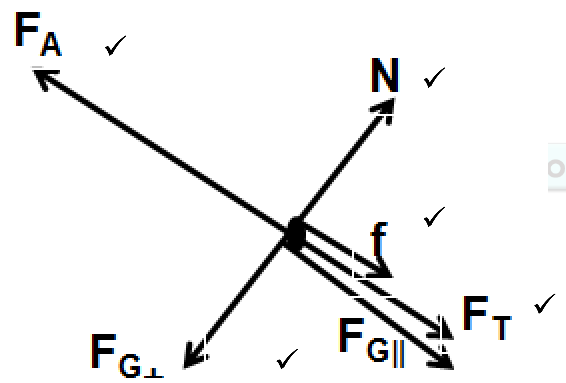
3.4. Q ✓

(1)

[12]

Question 4

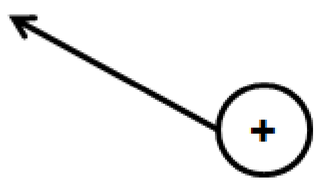
4.1. When a body exerts s force on a second body, the second body exerts a force of equal magnitude in the opposite direction on the first body.✓✓ (2)



4.2.

Accepted Labels	
F_G	Weight, gravitational force
F_A	Applied force
N	Normal force
F_T	Tension
f	Friction

(5)



4.3.

4.3.1. $f_k = \mu_k N$

$f_k = \mu_k mgcos\theta$ ✓

$f_k = (0{,}29)(1)(9{,}8)cos30°$ ✓

$f_k = 2{,}46\ N$ ✓

(3)

$F_{net} = ma$ ✓

<u>1kg</u>

$F_A + T + f + F_{G\parallel} = ma$

$40 - T - 2{,}46 - (1)(9{,}8)sin30°$ ✓ $= 1a$ ✓

$40 - T - 2{,}46 - 4{,}9 = a$

$32{,}64 - T = a$ ....(1)

<u>4kg</u>

$T + F_{G\parallel} + f = ma$

$T - (4)(9{,}8)sin30° - 10 = 4a$ ✓

$T - 19{,}6 - 10 = 4a$

$T - 29{,}6 = 4a$ ....(2)

(1) +(2)

$32{,}64 - T = a$

$\underline{T - 29{,}6 = 4a}$

$3{,}04 = 5a$

$a = 0{,}608\ m \cdot s^{-2}$

$\therefore\ T - 29{,}6 = (4)(0{,}61)$ ✓

$\therefore\ T = 32{,}04\ N$ ✓

(6)

[16]

Question 5

5.1.

5.1.1. When a body exerts s force on a second body, the second body exerts a force of equal magnitude in the opposite direction on the first body.✓✓

(2)

5.1.2. **<u>2,5kg</u>**

$F_{net} = ma = F_T + F_G$ ✓

$F_T - (2{,}5)(9{,}8) = (2.5)(0)$ ✓

$F_T = 24{,}5\ N$ ✓

(3)

5.1.3. $f_s = \mu_s N$ ✓

$24{,}5$ ✓ $= 0{,}2$ ✓ N

$N = 122{,}5\ N$

$N = -F_G$

$N = Mg$

$122{,}5 = M(9{,}8)$ ✓

$M = 12{,}5\ kg$ ✓

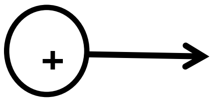
(5)

5.1.4. **5kg**

$f_k = \pi_k N$

$f_k = (0{,}15)(5)(9{,}8)$ ✓

$f_k = 7{,}35\ N$



$F_{net} = ma = F_T + f_k$ ✓

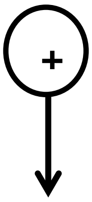
$5a = T - 7{,}35$ ✓ ....(1)

2,5kg

$F_{net} = ma = F_G + F_T$

$2{,}5a = (2{,}5)(9{,}8) - F_T$

$2{,}5a = 24{,}5 - F_T$ ✓ ....(2)



(1) + (2)

$5a = T - 7{,}35$

$2{,}5a = 24{,}5 - F_T$

$7{,}5a = 17{,}15$

$a = 2{,}29\ m \cdot s^{-2}$ ✓

(5)

$$F_G = \frac{Gm_1m_2}{r^2} \checkmark$$

$$F_G = \frac{(6{,}67 \times 10^{-11})(6{,}5 \times 10^{20})(90) \checkmark}{(550 \times 10^3)^2 \checkmark}$$

$F_G = 12{,}899\ N$ ✓

(4)

SESSION 06

Question 1

Multiple choice questions

1.1. D ✓✓

1.2. C ✓✓

1.3. B ✓✓

1.4. D ✓✓ **[4 × 2 = 8]**

Question 2

2.1. The total linear momentum in a closed system ✓ remains constant / is conserved✓.

(2)

2.2. $\Sigma p_i = \Sigma p_f$ ✓

$(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$

$(2m + 4m)(0)$ ✓ $= (2m)(2) + (4m)(v_{2f})$ ✓

$-4m = 4mv_{2f}$

$\therefore v_f = -1\ m \cdot s^{-1}$

$\therefore v_f = 1\ m \cdot s^{-1}$ ✓; in the opposite direction to that of the boys ✓

(5)

2.3. GREATER THAN ✓.

(1)

[8]

Question 3

3.1. $p = mv$ ✓

$p = (50)(5)$ ✓

$p = 250\ kg \cdot m \cdot s^{-1}$ ✓, (downwards)

(3)

3.2. The product of the net force and thee time interval (during which the force acts) ✓✓.

(2)

3.3. $\Delta p = F_{net}\Delta t$ ✓

$0 - 250$ ✓ $= F_{net}(0{,}2)$

$F_{net} = -1\ 250\ N$

$F_{net} = 1\ 250\ N$ ✓

(3)

3.4. GREATER THAN ✓

(1)

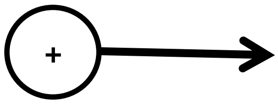
3.5. For the same momentum change ✓, the stopping time (contact time) will be smaller (less) ✓. ∴ the (upward) force exerted (on her) is greater ✓.

(3)

[12]

Question 4

4.1. $\Sigma p_i = \Sigma p_f$ ✓



$(m_1 + m_2)v_i = m_1 v_{1f} + m_2 v_{2f}$

$(3 + 0{,}02)(0)$✓ $= (3)(-1{,}4) + (0{,}02)v_{2f}$ ✓

$v_{2f} = 210\ m \cdot s^{-1}$ ✓

(4)

4.2. $v_f^2 = v_i^2 + 2a\Delta x$ ✓

$(0) = 210^2 + (2)(a)(0{,}4)$ ✓

$a = -55\ 125\ m \cdot s^{-2}$

$F_{net} = ma$ ✓

$F_{net} = (0{,}02)(-55\ 125)$ ✓

$F_{net} = -1\ 102{,}5\ N$

$\therefore F_{net} = 1\ 102{,}5\ N$ ✓

(5)

4.3. THE SAME ✓.

(1)

[10]

Question 5

5.1. The total linear momentum in a closed system remains constant/is conserved.✓✓

(2)

5.2.

5.2.1. $p_i = p_f$ ✓

$m_1 v_{i1} + m_2 v_{i2} = m_1 v_{f1} + m_2 v_{f2}$
$(m_1 + m_2) v_i = m_1 v_{f1} + m_2 v_{f2}$
0 ✓ $= (0{,}4) v_{f1} + (0{,}6)(4)$ ✓
$v_{f1} = -6\, m \cdot s^{-1}$
$= 6\, m \cdot s^{-1}$ *to the left* ✓
(4)

5.2.2. $\Delta p = F_{net} \Delta t$ ✓
$(0{,}6)(4 - 0)$ ✓ $= F_{net}(0{,}3)$ ✓
$F_{net} = 8\, N$ ✓
(4)

5.3. NO ✓
(1)

SESSION 06

Vertical Projectile Motion in One Dimension (1D)

Question 1
Multiple choice questions

1.1. A ✓✓
1.2. D ✓✓
1.3. D ✓✓
1.4. C ✓✓
1.5. B ✓✓ **[5 × 2 = 10]**

Question 2

2.1. 0,5 m ✓
(1)

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

$v_f^2 = (-2)^2 + (2)(-9{,}8)(-1{,}8)$ ✓

$v_f = -6{,}27\ m \cdot s^{-1}$ ✓

✓

$v_f = v_i + a\Delta t$

$-6{,}27 = -2 + (-9{,}8)\Delta t$ ✓

$\Delta t = 0{,}44\ s$ ✓

(5)

2.3. $v_f^2 = v_i^2 + 2a\Delta y$ ✓

$0^2 = v_i^2 + (2)(-9{,}8)(0,)$ ✓

$v_i = 4{,}2\ m \cdot s^{-1}$ ✓, upwards ✓

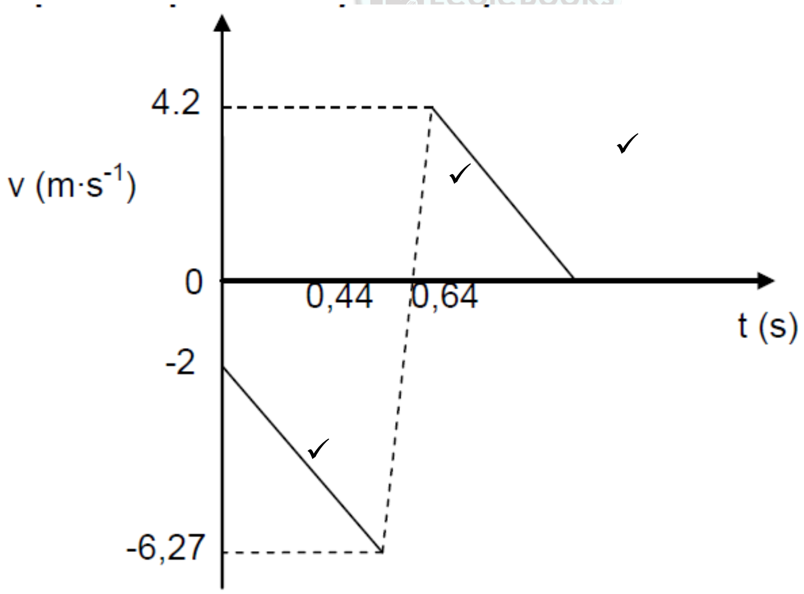
(4)

2.4. $F_{net}\Delta t = m\Delta v$ ✓ $= m(v_f - v_i)$

$F_{net}(0{,}2)$ ✓ $= (0{,}5)[(4{,}2 - (-6{,}27)]$ ✓

$F_{net} = 26{,}175\ N$ ✓

(4)



2.5.

(3)

Criteria for graph	Marks
First part of graph starts at v = 2 m·s^{-1} at t= 0 s and extends until v = 6,27 m·s^{-1} at t = 0,44 s.	✓
Graph is discontinuous and object changes direction at 0,64 s.	✓
Second part of graph starts at v = 4,2 m·s^{-1} at t= 0,64 s and extends until v =	✓

0 m·s^{-1}.	

[17]

Question 3

3.1. An object moving / Motion <u>under the influence of gravity / weight / gravitational force only ✓✓</u> (and there are no other forces such as friction).

(2)

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

0 ✓ $= -15\Delta t + \frac{1}{2}(9{,}8)\Delta t^2$ ✓

$\Delta t = 3{,}06\ s$

It takes 3,06 s ✓

(4)

3.3. $v_f^2 = v_i^2 + 2a\Delta y$ ✓

For ball A

$0 = (-15)^2$ ✓ $+ 2(9{,}8)\Delta y$ ✓

$\Delta y_A = -11{,}48\ m$

$\Delta y_A = 11{,}48\ m$, upwards

<u>When A is at highest point</u>

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

$\Delta y_B = 0 + \frac{1}{2}(9{,}8)(1{,}53)^2$ ✓✓

$\Delta y_B = 11{,}47\ m$, downwards

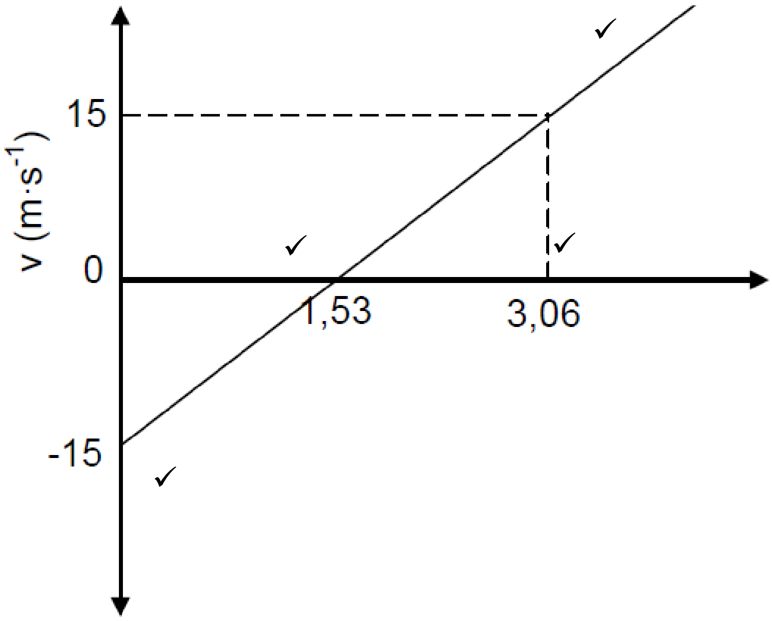
Distance $= y_A + y_B$

$= 11{,}48 + 11{,}47$ ✓

$= 22{,}95\ m$ ✓

(7)

3.4.



(4)

Criteria for graph	Marks
Graph starts at correct initial velocity shown.	✓
Time for maximum height shown (1,53 s) .	✓
Time for return shown (3,06 s).	✓
Shape: Straight line extending beyond 3,06 s.	✓

[17]

Question 4

4.1. Free fall ✓.

(1)

4.2.

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

30 ✓ $= v_i(1{,}5) + \frac{1}{2}(9{,}8)(1{,}5)^2$ ✓

$v_i = 12.65 \ m \cdot s^{-1}$ ✓

(4)

4.2.2. $v_f^2 = v_i^2 + 2a\Delta y$ ✓

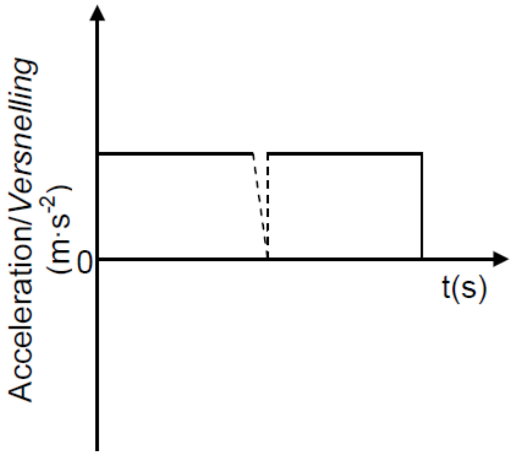
$2{,}65^2$ ✓ $= 0 + 299{,}8)\Delta y$ ✓

$\Delta y = 8{,}16 \ m$ ✓

Height $XC = XB + BC$

$XC = 30 + 8,16$
$XC = 38,16\ m$ ✓
(5)

4.3.



Criteria for graph	Marks
For each line correctly drawn as show	✓✓
Both axes correctly labelled.	✓

(3)

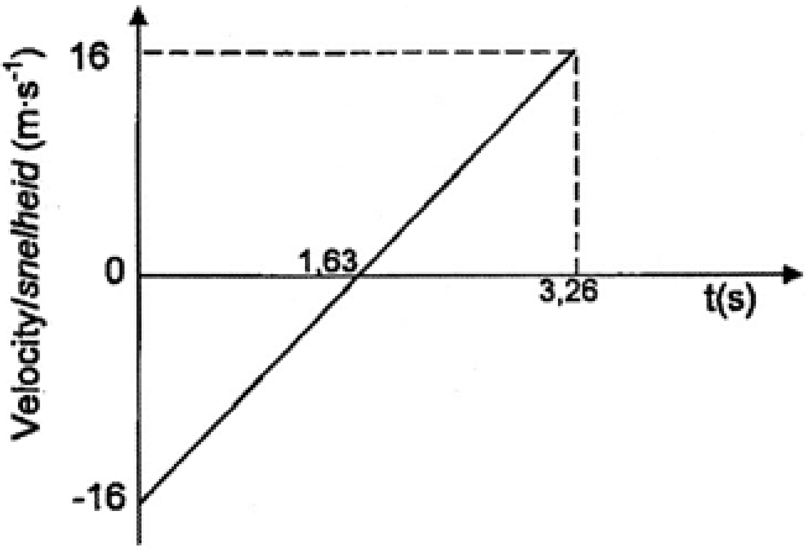
[13]

Question 5

5.1. $v_f = v_i + a\Delta t$ ✓
16 ✓ $= -16 + (9,8)\Delta t$ ✓
$\Delta t = 3,27\ s$ ✓
(4)

OR
(Top)
$v_f = v_i + a\Delta t$ ✓
0 ✓ $= -16 + (9,8)\Delta t$ ✓
$\Delta t = 1,63\ s$
Total time: $= (1,63)(2)$
$= 3,26\ s$ ✓

5.2.



(3)

Criteria for graph	Marks
Correct shape for line extending beyond t = 1,63 s.	✓
Initial velocity correctly indicated as shown.	✓
Time to reach maximum height and time to return to the ground correctly shown.	✓

5.3. **Marking criteria**

- Both equations ✓
- Equation for distance / displacement covered by A ✓.
- Equation for distance / displacement covered by B\ ✓
- One of the equations have time as (Δt + 1) or (Δt - 1).✓
- Solution for t. ✓
- Final answer: 11,25 m ✓

(6)

Take y_A as height of ball A from the ground.

$$\Delta y_A = v_i \Delta t + \frac{1}{2} a \Delta t^2$$
$$y_A - 0 = -16\Delta t + \frac{1}{2}(9{,}8)(\Delta t)^2$$
$$y_A = 16\Delta t - 4{,}9\Delta t^2 \checkmark$$

Take y_B as height of ball B from the ground.

$$\Delta y_B = v_i \Delta t + \frac{1}{2} a \Delta t^2$$
$$y_B - 30 = -v_i \Delta t + \frac{1}{2} a \Delta t^2$$
$$y_B = 30 - [9(\Delta t - 1) + \frac{1}{2}(9{,}8)(\Delta t - 1)^2 \checkmark$$
$$y_B = 34{,}1 + 0{,}8\,\Delta t - 4{,}9\Delta t^2 \checkmark$$

✓ Both

$y_A = y_B$

$16\Delta t - 4{,}9\Delta t^2 = 34{,}1 + 0{,}8\,\Delta t - 4{,}9\Delta t^2$
$15{,}2\Delta t = 34{,}1$
$\Delta t = 2{,}24\,s$ ✓

$\Delta y_A = (-16(2{,}24) + 4{,}9(2{,}24)^2$
$\Delta y_A = 11{,}25\,m$ ✓

[13]

Question 6

6.1. Downwards positive

6.1.1. $v_f^2 = v_i^2 + 2a\Delta y$ ✓

$v_f^2 = (2)^2 + 2(9,8)(45)$ ✓

$v_f = 29,77\ m \cdot m^{-1}$ ✓

(3)

6.1.2. The balls hit the water at the same instant.

Ball A

$v_f = v_i + a\Delta t$ ✓

$29,77 = 2 + (9,8)\Delta t$

$\Delta t = 2,83\ s$ ✓

Ball B

$\Delta t_B = 2,83 - 1$

$= 1,83\ s$ ✓

(3)

6.1.3.

$\Delta t_B = 1,83\ s$ ✓

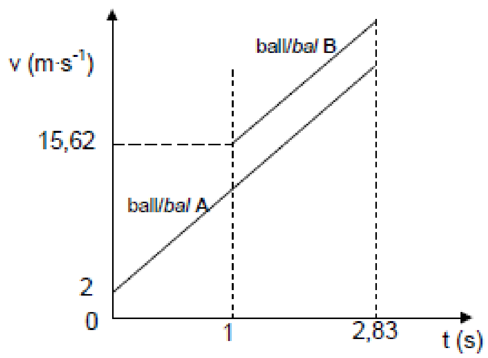
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓

45 ✓ $= v_i(1,83) + \frac{1}{2}(9,8)(1,83)^2$ ✓

$v_i = 15,62\ m \cdot s^{-1}$ ✓

(5)

6.2.



CRITERIA FOR MARKING	
1 mark for each initial velocity shown	✓✓
Time of release of ball B ($t = 1\ s$)	✓
Time of flight for both balls must be indicated as same on time axis	✓
Shape: lines must be parallel or nearly so	✓

(5)

16]

SESSION 07

Electrostatics MEMO

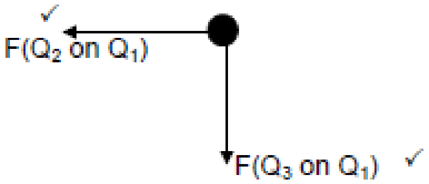
Question 1

1.1. C ✓✓
1.2. A ✓✓
1.3. A ✓✓
1.4. A ✓✓
1.5. B ✓✓

Question 2

2.1. The (magnitude) of the electrostatic force exerted by one charge on another is directly proportional to the (magnitudes of the) charges ✓ and inversely proportional to the square of the distance between their centres. ✓
(2)

2.2.



(2)

2.3.

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{Q2\ on\ Q1} = \frac{(9\times10^{9})(4\times10^{-6})(4\times10^{-6})}{(3\times10^{-3})^2}$ ✓ ✓

$F_{Q2\ on\ Q1} = 1{,}6 \times 10^4\ N$ left, *links*

$F_{Q3\ on\ Q1} = \frac{(9\times10^{9})(4\times10^{-6})(4\times10^{-6})}{(3\times10^{-3})^2}$ ✓

$F_{Q3\ on\ Q1} = 1{,}6 \times 10^4\ N$ downwards

$F_{net} = \sqrt{(F_{Q2\ on\ Q1})^2 + (F_{Q3\ on\ Q1})^2}$

$F_{net} = \sqrt{(1{,}6 \times 10^4)^2 + (1{,}6 \times 10^4)^2}$ ✓

$F_{net} = 2{,}26 \times 10^4$

$\tan\theta = \left(\frac{F_{Q3\ on\ Q1}}{F_{Q2\ on\ Q1}}\right)$

$\tan\theta = \left(\frac{1{,}6\times10^4}{1{,}6\times10^4}\right)$

$\therefore\ \theta = 45^{\circ}$

$F_{net} = 2{,}26 \times 10^4 N$ ✓ 45º south of west / *225º* ✓

(8)

[12]

Question 3

3.1. The force ✓per unit charge ✓ at that point. (2)

3.2. $E = \frac{kQ}{r^2}$ ✓

$E = \frac{(9 \times 10^9)(6,5 \times 10^{-12})}{(0.003)^2}$ ✓

$E = 6,5 \times 10^3 \ N \cdot C^{-1}$ ✓ (3)

3.3. **At point X**

$E_Q = 6,5 \times 10^3 \ N \cdot C^{-1} \ West$ ✓

$E_R = \frac{kQ}{r^2}$

$E_R = \frac{(9 \times 10^9)(6,5 \times 10^{-12})}{(0.003)^2}$

$E_R = 6,5 \times 10^3 \ N \cdot C^{-1} \ East$ ✓

$E_{net} = E_Q + E_R$ ✓

$E_{net} = 6,5 \times 10^3 + (-6,5 \times 10^3)$

$E_{net} = 0 \ N \cdot C^{-1}$ ✓ (4)

[9]

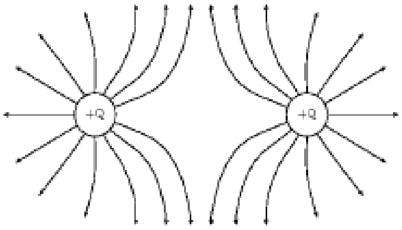
Question 4

4.1. To ensure that charge does not leak to the ground/insulated. ✓ (1)

4.2. Net charge $= \frac{Q_R + Q_S}{2}$

$Q_{net} = \frac{+8 + (-4)}{2}$ ✓

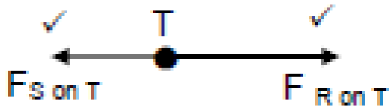
$Q_{net} = 2\mu C$ ✓ (2)



4.3.

(3)

Criteria	Marks
Correct direction of field lines	✓
Shape of the electric field	✓
No field line crossing each other	✓



4.4. (2)

4.5. **OPTION 1**

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F_{ST} = \frac{(9\times10^9)(1\times10^{-6})(2\times10^{-6})✓}{(0,2)^2✓}$

$F_{ST} = 0,45\ N$ left

$F_{RT} = \frac{(9\times10^9)(2\times10^{-6})(1\times10^{-6})}{(0,1)^2}$ ✓

$F_{RT} = 1,8\ N$ right

$F_{net} = F_{ST} + F_{RT}$

$F_{net} = 1,8 + (-0,45)$ ✓

$F_{net} = 1,35\ N$ right or towards sphere S ✓ (6)

4.6. Force experienced ✓ per unit positive charge ✓ placed at that point. (2)

4.7. **OPTION 1**

$E = \frac{F}{q}$ ✓

$E = \frac{1,35}{1\times10^{-6}}$ ✓

$E = 1,35 \times 10^6 N\cdot C^{-1}$ ✓

OPTION 2

$E = \frac{F}{q}$ ✓

$E = \frac{1,8}{1\times10^{-6}}$ ✓

$E = 1,8 \times 10^6 N\cdot C^{-1}$

$E = \frac{0,45}{1\times10^{-6}}$

$E = 4,5 \times 10^5 N\cdot C^{-1}$

$E_{net} = 1,8\times10^6 - 4,5\times10^5$

$E_{net} = 1,35\times10^6 N\cdot C^{-1}$ ✓ (3)

[19]

Question 5

5.1 The net electrostatic force on a charged particle due to the presence of another charged particle is directly proportional to the product of the charges✓and inversely proportional to the square of the distance between them (their centres) ✓

OR

The force of attraction or repulsion between two point charges is directly proportional to the product of the charges ✓and inversely proportional to the square of the distance between them. ✓

(2)

5.2

5.2.1 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$1{,}44 \times 10^{-1}$ ✓ $= \frac{(9 \times 10^9)Q^2}{(0{,}5)^2}$ ✓

$Q = 2 \times 10^{-6}\ C$ ✓ (4)

5.2.2 **Positive marking from QUESTION 5.2.1**

$Q = ne$ ✓

$2 \times 10^{-6} = n(1{,}6 \times 10^{-19})$ ✓

$n = 1{,}25 \times 10^{13}\ e^-$ ✓ (3)

5.3

5.3.1 Left (west) ✓ (1)

5.3.2 Take right as positive

$E_{net} = E_A + E_B$ ✓

$(3 \times 10^4) = -\frac{(9 \times 10^9)(2 \times 10^{-6})}{(1{,}5)^2}$ ✓ $+ \frac{(9 \times 10^9)\,Q_f}{(1)^2}$ ✓

$Q_f = 4{,}22 \times 10^{-6}$ C✓

$Q = ne$

$4{,}22 \times 10^{-6} = n1{,}6 \times 10^{-19}$ ✓

$n = 2{,}64 \times 10^{13}\ e^-$✓

Electrons removed

$= 2{,}64 \times 10^{13} + 1{,}25 \times 10^{13}$ ✓

$= 3{,}89 \times 10^{13}\ e^-$✓ (8)

[18]

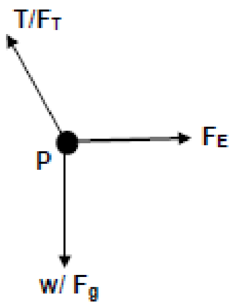
Question 6

4.1 $n = \frac{Q}{e}$ ✓

$n = \frac{0,5\times10^{-6}}{1,6\times10^{-19}}$ ✓

$n = 3,13 \times 10^{12}\ e^{-}$ ✓ (3)

4.2



Accepted labels/*Aanvaarde benoemings*	
w	F_g / F_w / weight / mg / gravitational force *F_g / F_w / gewig / mg / gravitasiekrag*
T	F_T / tension *F_T / spanning*
F_E	Electrostatic force/F_C/ Coulombic force/F_Q /F_{RPPR} *Elektrostiesekrag / Coulombkrag / F_Q /F_{RPPR}*

(3)

4.2.1 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)

4.3

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^{9})(0,5\times10^{-6})(0,9\times10^{-6})}{(0,2)^2 ✓}$ ✓

$F = 0,101$

$\tan 7^{\circ} = \frac{T_X}{T_Y} = \frac{0,101}{T_X}$ ✓

$T_Y = 0,823\ N$

$T = \sqrt{T_X^2 + T_Y^2}$

$T = \sqrt{(0,101)^2 + (0,823)^2}$

$T = 0,83\ N$ ✓

(5)

[13]

Question 7

$$7.1 E = \frac{kQ}{r^2} ✓$$

$E_X = E_2 + E_{-8}$ ✓

$E_X = \frac{(9\times 10^9)(2\times 10^{-5})}{(0{,}25)^2}$ ✓ $+ \frac{(9\times 10^9)(8\times 10^{-6})}{0(0{,}15)^2}$ ✓

$E_X = 6{,}08 \times 10^6 N \cdot C^{-1}$ ✓ to the east ✓ (6)

7.2 $F_E = QE$ ✓

$F_E = (-2\times 10^{-9})(6{,}08\times 10^6)$ ✓

$F_E = -12{,}16 \times 10^{-3} N$

$F_E = 12{,}16 \times 10^{-3} N$ ✓ to the west ✓ (4)

7.3 $2{,}44 \times 10^{-2}$ N ✓ / Twice (1)

[11]

Question 8

8.1 The magnitude of the charges are equal ✓/ The balls repel each other with the same/identical force or force of equal magnitude ✓.

(1)

8.2 The electrostatic force of attraction between two point charges is directly proportional to the product of the charges ✓ and inversely proportional to the square of the distance between them. ✓ (2)

8.3.1 $T\cos 20º = W$ ✓

$T\cos 20º = mg$

$T\cos 20º = (0{,}1)((9{,}8)$ ✓

$T\cos 20º = 0{,}98$

$T = 1{,}04\ N$ ✓ (3)

8.4.1 **POSITIVE MARKING FROM 8.3.1**

$F_{electrostatic,elektrostaties} = T\sin 20º$ ✓

$\frac{kQ_1Q_2}{r^2}$ ✓ $= T\sin 20º$

$\frac{(9\times 10^9)(250\times 10^{-9})(250\times 10^{-9})}{r^2}$ ✓ $= 1{,}04\sin 20º$

$\frac{(9\times 10^9)(250\times 10^{-9})(250\times 10^{-9})}{r^2} = 0{,}356$ ✓

$r = 0{,}0397\ m$ ✓ (5)

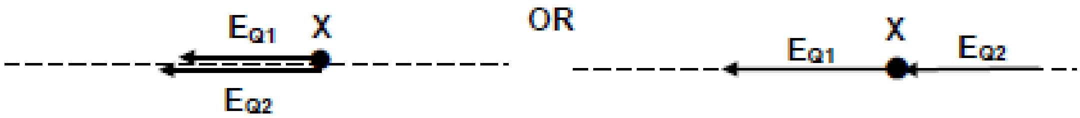
[11]

Question 9

9.1 Vectors E_{Q1} and E_{Q2} in the same direction✓✓

Correct drawing of vectors E_{Q1} and E_{Q2}✓✓

The fields due to the two charges add up because they come from the same direction. Hence the field cannot be zero (4)



9.2 $E = \frac{kQ}{r^2}$ ✓

$E_{-2.5} = \frac{(9 \times 10^9)(2{,}5\times 10^{-6})}{(0{,}3)^2}$ ✓

$E_{-2.5} = 250\ 000\ N \cdot C^{-1}\ left$

$E_5 = \frac{(9 \times 10^9)(6 \times 10^{-6})}{(1{,}3)^2}$ ✓

$E_5 = 31\ 952{,}66\ N \cdot C^{-1}\ left$

$E_P = E_6 + E_{-2.5}$ ✓

$E_P = 31\ 952{,}66 + 250\ 000$

$E_P = 281\ 952{,}66\ N \cdot C^{-1}$ ✓$left$ ✓ (6)

[10]

SESSION 07

Organic Chemistry

Question
Multiple-choice Questions

1.1. A ✓✓ (2)

1.2. B ✓✓ (2)

1.3. C ✓✓ (2)

1.4. B ✓✓ (2)

1.5. A ✓✓ (2)

1.6. B ✓✓ (2)

1.7. A ✓✓ (2)

1.8. D ✓✓ (2)

1.9. C ✓✓ (2)

1.10A ✓✓ (2)

1.11C ✓✓ (2)

1.12 B ✓✓ (2)

1.13 B ✓✓ (2)

1.14 D ✓✓ (2)

Question 2

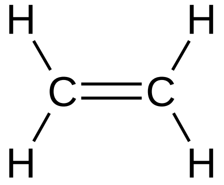
2.1.

2.1.1. Alkynes ✓ (1)

2.1.2. Hydroxyl group ✓ (1)

2.1.3. C ✓ (1)

2.1.4. 2-methylpentan-3-one ✓✓ (2)

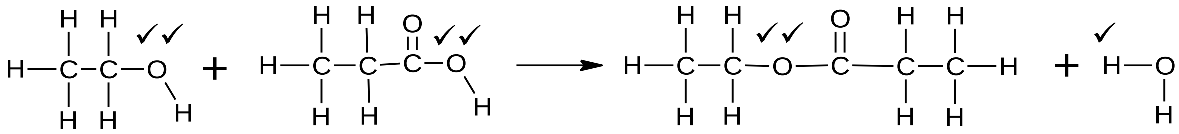
2.1.5. 

✓✓ (2)

2.1.6. $2C_4H_{10} + 13O_2$ ✓ $\longrightarrow 8CO_2 + 10H_2O$ ✓ $Bal.$ ✓ (3)

2.2. Same molecular formula, ✓ but different positions of the functional group.✓

(2)

2.3. 

(7)

[19

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Question 3

3.1.

3.1.1. B ✓ (1)

3.1.2. E ✓ (1)

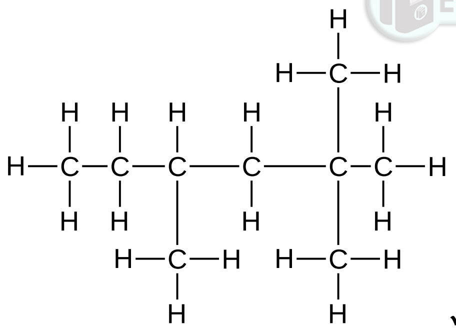
3.1.3. F ✓ (1)

3.2.

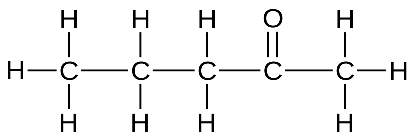
3.2.1. 2-bromo-3-chloro-4-methylpentane ✓✓✓ (3)

3.2.2. Ethene ✓ (1)

3.3.



3.3.1. ✓✓ (2)



3.3.2. ✓✓ (2)

3.4.

3.4.1. Compounds with the same molecular formula ✓ but different functional groups / different homologous series. ✓

Verbindings met dieselfde molekulêre formule, maar verskillende funksionele groepe / verskillende homoloë reeks.

(2)

3.4.2. B & F ✓ (1)

[14]

Question / Vraag 4

4.1.

4.1.1. Carboxyl group / Karboksielgroep ✓ (1)

4.1.2. Ketones / Ketone ✓ (1)

4.2.

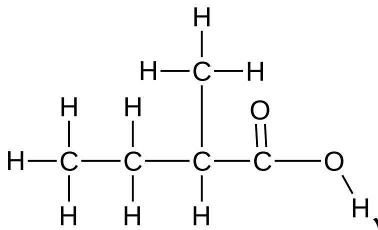
4.2.1. Ethene / Eteen ✓ (1)

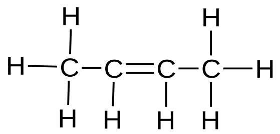
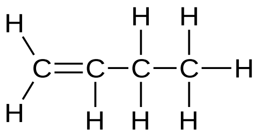
4.2.2. 4-methylhexan-3-one ✓✓
4-metielheksaan-3-oon (2)

4.2.3. 4-ethyl-2,2-dimethylhexane
4-etiel-2,2-dimetielheksaan ✓✓ (2)

4.3. Carbon dioxide / Koolstofdioksied / CO_2 ✓
Water / H_2O ✓ (2)

4.4.

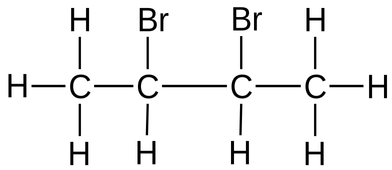
4.4.1.  ✓✓ (2)

4.4.2.  OR/OF  ✓✓ (2)

4.5.

4.5.1. **E** ✓ (1)

4.5.2. Substitution / halogenation / bromination ✓
Substitusie / halogenering / brominering (1)

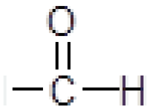
4.5.3.  ✓✓ (2)

[18]

Question / Vraag 5

5.1.

5.1.1. B ✓ (1)

5.1.2.  ✓ (1)

5.1.3. C_nH_{2n-2} ✓ (1)

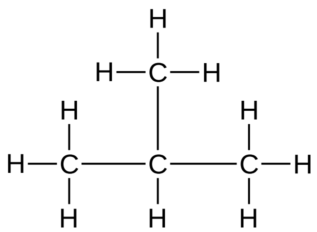
5.1.4. 4-ethyl-5-methylhept-2-yne ✓✓✓
4-etiel-5-metielhept-2-yn (3)

5.1.5. Butan-2one / Butan-2-oon ✓✓ (2)

5.2.

5.2.1. Alkanes / Alkane ✓ (1)

5.2.2. Methylpropane / Metielpropaan ✓✓



✓✓ (4)

5.3.

5.3.1. Haloalkanes / Alkyl halides ✓
Haloalkane / Alkielhaliede (1)

5.3.2. Substitution / halogenation / bromonation ✓
Substitusie / halogenering / halogenasie / bromonering (1)

[16]

Question / Vraag 6

1.14.1 Ketones / *ketone* ✓

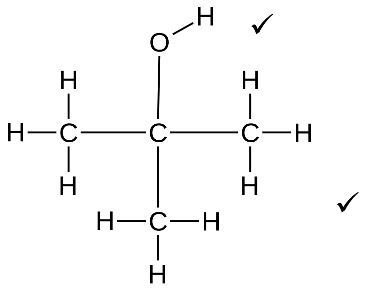
(1)

1.14.2 3,5-dichloro✓-4-methyl✓octane✓

3,5-dichloor-4-metieloktaan OF 3,5-dichloro-4-metieloktaan

(3)

1.14.3



(2)

1.15

1.15.1 Acts as catalyst./increases the rate of the reaction./act as dehydrating agent.✓
Tree as katalisator op./Verhoog die tempo van die reaksie./Tree as dehireermiddel op. (1)

1.15.2 Water/H_2O (1)

1.15.3

C	:	H	:	O
$\frac{40}{12}$ ✓	:	$\frac{6,67}{1}$ ✓	:	$\frac{53,33}{16}$ ✓
3,33	:	6,67	:	3,33
1	:	2	:	1 ✓

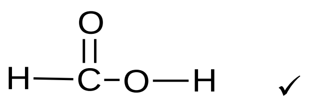
Empirical formula/Empiriese formule: CH_2O ✓ (5)

1.15.4 $M(CH_2O) = 30\ g \cdot mol^{-1}$ ✓

$Formula - \frac{unts}{Formule} - eenhede\text{:}\ \frac{60}{30} = 2$ ✓

$Molecular\ formula\ /\ Molekulêre\ formule\ =\ C_2H_4O_2$ ✓ (3)

1.15.5



✓ (1)

1.15.6 Methyl✓methanoate✓
Metielmetanoaat (2)

[19]

Question / Vraag 7

7.1 Temperature ✓ at which the vapour pressure of the substance equals atmospheric pressure. ✓
Temperatuur waar die dampdruk van die stof gelyk is aan atmosferiese druk. (2)

7.2

7.2.1 Boiling point increases as the chain length / molecular mass increases.✓
Kookpunt neem toe soos wat die kettinglengte / molekulêre massa toeneem.
OR / OF
Boiling point increases from methane to butane.
Kookpunt neem toe van metaan na butaan. (1)

7.2.2

- Chain length increases from methane to butane.✓
  Kettinglengte neem toe van metaan na butaan.
- Strength of Londen forces / induced dipole forces increases from methane to butane. ✓
  Sterkte van Londonkragte / geïnduseerde dipoolkragte neem toe van metaan na butaan.
- More energy needed to overcome intermolecular forces in butane than in methane.✓
- Meer energie benodig om intermolekulêre kragte in butaan as in metaan te oorkom. (3)

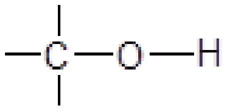
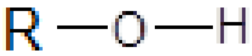
7.3 Between molecules of the alkanes are weak London forces or induced dipole forces.✓
Tussen molecule van alkane is swak Londonkragte of geïnduseerde dipool kragte.
Between alcohol molecules are, in addition to weak London Forces or induced dipole forces, also strong hydrogen bonds.✓
Tussen alkoholmolekule is sterk waterstofbindings bykomend by tot swak Londonkragte of geïnduseerde dipoolkragte. (2)

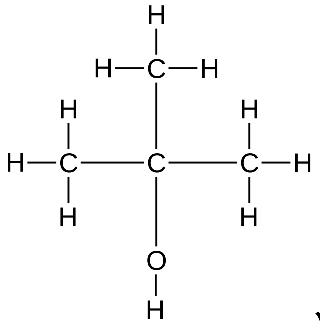
[8]

Question / Vraag 8

8.1 Alkanes have ONLY single bonds between C-atoms.✓
Alkane het SLEGS enkelbindings tussen C-atome. (1)

8.2

8.2.1  OR / OF  (1)

8.2.2  ✓✓ (2)

8.3

8.3.1 What is the relationship between chain length / molecular size / molecular structure / molecular mass / surface area and boiling point?✓✓
Wat is die verwantskap tussen kettinglengte / molekulêre grootte/ molekulêre struktuur / molekulêre massa / oppervlakte en kookpunt? (2)

8.3.2

- **<u>Structure / *Struktuur*</u>:**
  The chain length / molecular size / molecular structure / molecular mass / surface area increases. ✓
  Die kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte neem toe.
- **<u>Intermolecular forces / *Intermolekulêre kragte*</u>:**
  Increase in strength of intermolecular forces / induced dipole / London / dispersion / Van der Waals forces. ✓
  Toename in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte / Van der Waalskragte.
- **<u>Energy / *Energie*</u>:**
  More energy needed to overcome / break intermolecular forces. ✓
  Meer energie benodig om intermolekulêre kragte te oorkom / breek.

OF / OR

- **<u>Structure / *Struktuur*</u>:**
  From propane to methane the chain length / molecular size / molecular structure / molecular mass / surface area decreases.

Van propaan na metaan neem die kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte af.

- **Intermolecular forces / *Intermolekulêre kragte:***
  Decrease in strength of intermolecular forces / induced dipole forces / London forces / dispersion forces.
  Afname in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte.
- **Energy / *Energie*:**
  Less energy needed to overcome / break intermolecular forces.
  Minder energie benodig om intermolekulêre kragte te oorkom / breek.

(3)

8.4

- Between propane molecules are London forces / dispersion forces / induced dipole forces. ✓
  Tussen propaanmolekule is Londonkragte / dispersiekragte / geïnduseerde dipoolkragte.
- Between propan-1-ol molecules are London forces / dispersion forces / induced dipole forces and hydrogen bonds. ✓
  Tussen propan-1-ol molekule is Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en waterstofbindings.
- Hydrogen bonds / Forces between alcohol molecules are stronger or need more energy than London forces / dispersion forces / induced dipole forces. ✓
- Waterstofbindings / Kragte tussen alkoholmolekule is sterker of benodig meer energie om oorkom te word as Londonkragte / dispersiekragte / geïnduseerde dipoolkragte.
  (3)

OR / OF

Between propane molecules are weak London forces / dispersion forces / induced dipole forces ✓ and between propan-1-ol molecules are strong hydrogen bonds. ✓✓
Tussen propaanmolekule is swak Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en tussen propan-1-olmolekule is sterk waterstofbindings. **[12]**

Question / Vraag 9

9.1 C ✓ (1)

9.2

9.2.1 Chain length / molecular size / molecular mass / number of carbon atoms in the chain ✓
Kettinglengte / molekulêre grootte / molekulêre massa / aantal koolstof-atome in die ketting. (1)

9.2.2 Boiling point ✓
Kookpunt (1)

9.3 London forces / induced dipole forces / dispersion forces ✓
Londonkragte / geïnduseerde dipool kragte / dispersie kragte(1)

9.4 Higher than / Hoër as ✓ (1)

9.5 Lower than/Laer as ✓

- Both compounds D and E have hydrogen bonding between molecules.✓
  Beide verbindings D en E het waterstofbinding tussen molekule.
- Compound D has one site for hydrogen bonding whilst compound E has two sites for hydrogen bonding / forms dimers.✓
  Verbinding D het een punt vir waterstofbinding terwyl verbinding E twee punte het vir waterstofbinding./vorm dimere
- More energy needed to overcome intermolecular forces in compound E / less energy needed to overcome intermolecular forces in compound D. ✓
  Meer energie nodig om die intermolekulêre kragte te oorkom in verbinding E / minder energie nodig om die intermolekulêre kragte in verbinding D te oorkom.

(4)

[9]

Question / Vraag 10

10.1 A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds.✓✓
'n Binding of 'n atom of groep atome wat die fisiese en chemise eienskappe van 'n groep organese verbindings bepaal. (2)

10.2
10.2.1 D / ethanoic acid / etanoësuur ✓
Lowest vapour pressure / Laagste dampdruk ✓ (2)
10.2.2 A / butane / butaan ✓ (1)

10.3
- Between molecules of A / butane / alkanes are London / induced dipole forces / dispersion forces.✓
  Tussen molecule van A / butaan / alkane is London kragte / geïnduseerde dipole kragte / dispersie kragte.
- Between molecules of B / propan-2-one / ketones are dipole-dipole forces in addition to London / induced dipole/ dispersion forces.✓
  Tussen molecule van B / propan-2-oon / ketone is dipool-dipool-kragte tesame met London / geïnduseerde dipole / dispersiekragte.
- Intermolecular forces in B are stronger than those in A, more energy is needed in B to break / overcome intermolecular forces. ✓
  Intermolelekulêre kragte in B is sterker as die in A, meer energie word by B benodig om intermolekulêre kragte te breek / oorkom. (3)

10.4 London / induced dipole forces / dispersion forces / dipole-dipole forces✓
London kragte / geïnduseerde dipole kragte / dispersie kragte / dipool-dipool-kragte (1)

10.5
- Compound D has more sites for hydrogen bonding than compound C.✓
- Verbinding D het meer punte vir waterstofbinding asl verbinding C.
- More energy needed to overcome intermolecular forces in compound C / less energy needed to overcome intermolecular forces in compound D. ✓
- Meer energie nodig om die intermolekulêre kragte te oorkom in verbinding C / minder energie nodig om die intermolekulêre kragte in verbinding D te oorkom.

(2)

10.6

	C_4H_{10}	O_2	CO_2	H_2O
Initial V (cm^3) Begin V (cm^3)	8	60	0	0
Change in V (cm^3) Verandering V (cm^3)	8	52✓	32✓	40✓

Final V (cm^3) Finale V (cm^3)	0	8✓	32	40

$Total$ / $Totale\ volume$ $= 8 + 32 + 40 = 82\ cm^3$✓ (5)

[16]

Question / Vraag 11

11.1 Temperature✓ at which the vapour pressure equals atmospheric pressure.✓

Temperatuur waar die damp druk gelyk is aan atmosferiese druk.

(2)

11.2 The stronger the intermolecular forces, the higher the boiling point.
Hoe sterker die intermolekulêre kragte, hoe hoër die kookpunt.

(1)

11.3
11.3.1

- In A/propane/alkanes: London forces/dispersion forces/induced dipole forces. ✓
  In A/propaan/alkane: Lodonkragte/dispersiekragte /geïnduseerde dipoolkragte
- In B/propan-2-one/ketones: dipole-dipole forces✓ in additions to London forces/dispersion forces/induced dipole forces
  Lodonkragte/dispersiekragt /geïnduseerde dipoolkragte
  In B/propan-2-oon/ketone: dipool-dipool kragte tesame met
- Intermolecular forces in A are weaker ✓ than in B./Intermolecular forces in B are stronger than in A./Lodon forces are weaker than dipole-dipole forces.
  Intermolekulêre kragte in A swakker as in B./Intermolekulêre kragte in B sterker as in A./Londonkragte is swakker as dipool-dipoolkragte.

(3)

11.3.2

- Both C and D: hydrogen bonding ✓
  Beide C en D: waterstofbinding
- D has two/more sites for hydrogen bonding/ D forms dimers/ D is more polar./C has one/less sites for hydrogen bonding.✓
  D het twee/meer plekke vir waterstofbindings./D votm dimere./D is meer polêr./C het een/minder plekke vir waterstofbinding.
- D has stronger intermolecular forces than C./C has weaker intermolecular forces than D. ✓
  D het sterker intermolekulêre kragte as C./C het swakker intermolekulêre kragte as D. (3)

11.4 Liquid/Vloeistof ✓ (1)

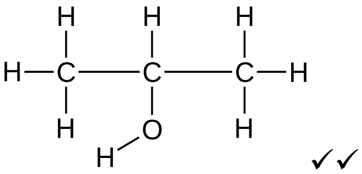
[10]

Question / Vraag 12

12.1 Alkenes / Alkene ✓ (1)

12.2

12.2.1 Addition / Hydrohalogenation / Hydrochlorination ✓
Addisie / Hidrohalogenering / Hidrochloronering (1)

12.2.2 

Propan-2-ol ✓ (3)

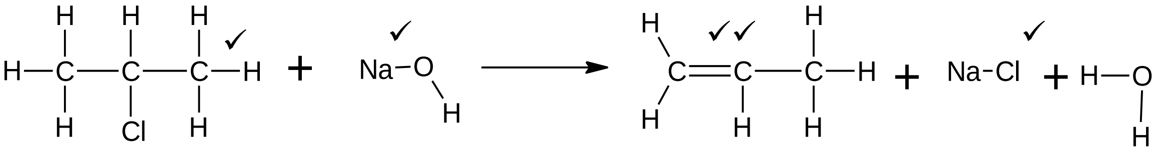
12.2.3 Elimintion / Dehydration✓
Eliminasie / Dehidrasie (1)

12.2.4 Catalyst / Katalisator ✓ (1)

12.3

12.3.1 Sodium hydroxide / Potassium hydroxide ✓
Natriumhidroksied / Kaliumhidroksied (1)

12.3.2 Dissolve base in ethanol / Concentrated (strong) base✓
Heat strongly ✓
Los basis op in etanol / Gekonsentreerde (sterk) base
Verhit sterk (2)

12.3.3 

(5)
[15]

Question / Vraag 13

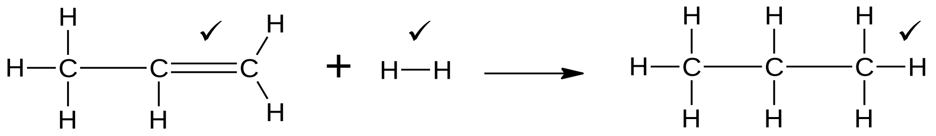
13.1

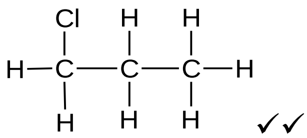
13.1.1 Substitution / chlorination / halogenation ✓
Substitusie / choronering / halgenering / halogenasie (1)

13.1.2 Substitution / hydrolysis ✓
Substitusie / hidrolise (1)

13.2

13.2.1 Hydrogenation / Hidrogenasie / Hidrogenering ✓ (1)

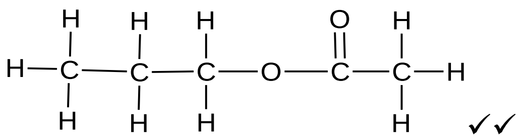
13.2.2  (3)

13.3  (2)

13.4

13.4.1 Esterfication / Condensation ✓
Verestering / Esterfikasie / Kondensasie (1)

13.4.2 Consentrated H_2SO_4 / Concentrated sulphuric acid ✓
Gekonsentreerde H_2SO_4 / Gekonsentreerde swawelsuur / swaelsuur (1)

13.4.3  (2)

13.4.4 Propyl ethanoate / Propieletanoaat ✓✓ (2)

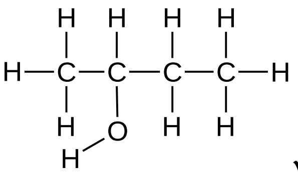
13.5 Sulphuric acid / H_2SO_4 / Phosphoric acid / H_2PO_4 ✓
Swawelsuur / Swaerlsuur / H_2SO_4 / Fosforsuur / H_2PO_4 (1)

[15]

Question / Vraag 14

14.1 Unsaturated ✓ - Contains a double bond / multiple bond between c-atoms ✓
Onversadig – Bevat 'n dubbelbinding / meervoudige binding tussen C-atome (2)

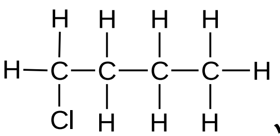
14.2

14.2.1  ✓✓ (2)

14.2.2 Addition / hydration ✓
Addisie / hidrasie (1)

14.3

14.3.1 2-chlorobutane / 2-chlorobutaan ✓✓ (2)

14.3.2  ✓✓ (2)

14.4

14.4.1 H_2O OR dilute NaOH / KOH ✓
H_2O OF verdunde NaOH / KOH
Mild heat / Matige hitte ✓ (2)

14.4.2 Substitution / Hydrolysis ✓
Substitusie / Hydrolise (1)

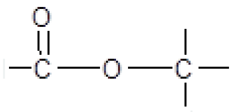
14.4.3 $C_4H_9C\ell + NaOH$ ✓ $\rightarrow$ $C_4H_{10}O + NaC\ell$ ✓ bal. ✓
OR / OF
$C_4H_9C\ell + H_2O$ ✓ $\rightarrow$ $C_4H_{10}O + HC\ell$ ✓ bal. ✓ (3)

[15]

Question / Vraag 15

15.1

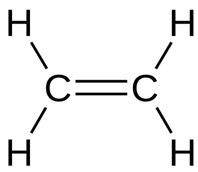
15.1.1 Esterfication / Condensation ✓
Esterfikasie / Verestering / Kondensasie (1)

15.1.2  ✓ (1)

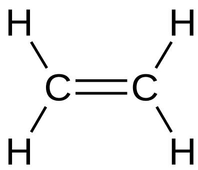
15.1.3 Propanoic acid / Propanoësuur ✓ (1)

15.1.4 Dehydration / Elimination ✓
Dehidrasie / Dehidratering / Eliminasie (1)

15.1.5 Consentrated sulphuric acid / H_2SO_4 / Phosphoric acid / H_2PO_4 ✓
Gekonsentreerde swawelsuur / Swaerlsuur / H_2SO_4 / Fosforsuur / H_2PO_4
(1)

15.1.6  ✓✓ (2)

15.2

15.2.1  ✓✓ (2)

15.2.2 Addition / Addisie ✓ (1)

[10]

Question / Vraag 16

16.1

16.1.1 Addition / Addisie ✓ (1)

16.1.2 Polyethene/Polythene/Polyethelene ✓
Polieteen/Politeen/Polietileen (1)

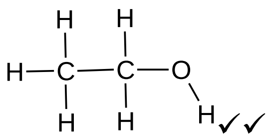
16.2

16.2.1 Chloro✓ethane✓
Chloroetaan/chloretaan (2)

16.2.2 Hydrohalogenation/hydrochlorination ✓
Hidrohalogenering/hidrochloronereing (1)

16.3

16.3.1



(2)

16.3.2 $HC\ell$/hydrogen chloride/waterstofchloried ✓ (1)

16.4

16.4.1 Saturated/Versadig✓
There are no double/multiple bonds between C-atoms./Carbon atoms are bonded to the maximum number of H-atoms.✓
Daar is geen dubbel- of meervoudige bindings tussen C-atome./Koolstof-atome gebind aan maksimum aantal H-atome. .
(2)

16.4.2 H_2/hydrogen (gas)/waterstog (gas) ✓ (1)

16.4.3 $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ ✓✓✓ (3)

[14]

Question 1

1.1. C ✓✓
1.2. D ✓✓
1.3. C ✓✓
1.4. D ✓✓
1.5. B ✓✓

Question 2

2.1.1. From graph: $\frac{R}{V}$ ✓
From equation: $\frac{r}{E}$ (1)

2.1.2. $\frac{1}{E} = 0,65$ ✓
$\therefore E = 1,54\ V$ ✓ (2)

2.1.3. $\frac{r}{E} = \frac{2-1}{4-1}$ ✓✓
$\therefore r = 0,51\ \Omega$ ✓ (3)
$(Any\ set\ of\ values)$

2.2.1. $\varepsilon = I(R + r)$ ✓
$6 = I(9 + 1)$ ✓
$I = 0,6\ A$ ✓ (3)

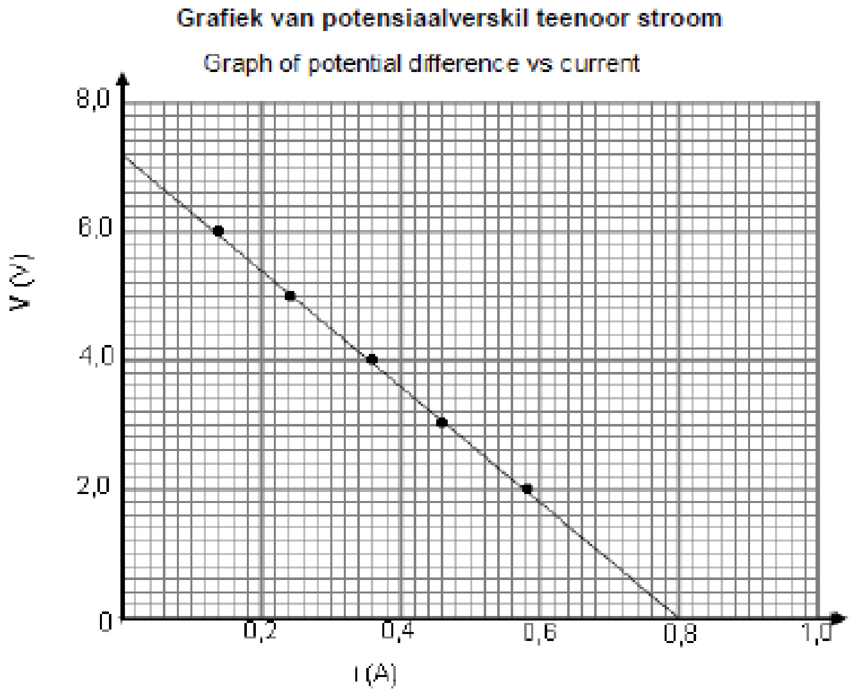
2.2.2. $P = I^2R$ ✓
$1,8 = (0,6)^2 R_1$ ✓
$R_1 = 5\Omega$
$R_p = 9 - 5$
$R_p = 4\Omega$ ✓
$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{4} = \frac{1}{R_2} + \frac{1}{4R_2}$ ✓
$R_2 = 5\Omega$ ✓ (5)

2.3. $W = VI\Delta t$ ✓
$W = (240)(9,5)(12)(60)$ ✓
$W = 1,64 \times 10^6 J$
Cost $= \frac{1,64 \times 10^6}{3,6 \times 10^6} \times 1,47$ ✓
Cost $= R\ 0,67$ ✓ (4)

[18]

Question 3

3.1.1. Keep the temperature (of battery) constant ✓ (1)



3.1.2.

Criteria for drawing line of best fit:/*Kriteria vir teken van lyn van beste pas:*	Marks/ *Punte*
ALL points correctly plotted (at least 4 points) *ALLE punte korrek gestip (ten minste 4 punte)*	✓✓
Correct line of best fit if all plotted points are used (at least 3 point) *Korrekte lyn van beste pas indien alle punte gebruik word (ten minste 3 punte)*	✓

(3)

3.1.3. 7,2 V ✓ (7,0 – 7,4)
(1)

3.1.4. $slope = \frac{\Delta V}{\Delta I}$

$slope = \frac{0-7,2✓}{0,8-0✓}$

$slope = -9$

$r = 9\Omega$ ✓ (3)

3.2.1. $P = VI$✓

$100 = 20I$ ✓

$I = 5\ A$ ✓
(3)

3.2.2. $P = \frac{V^2}{R}$ ✓

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$P = \frac{20^2}{150}$ ✓
$P = 2{,}67\ \Omega$ ✓
(3)

3.2.3. $P = VI$
$150 = 20I_{150W}$ ✓
$I_{150W} = 7{,}5\ A$
$I_{tot} = (5 + 7{,}5)$ ✓

$\varepsilon = I(R + r)$ ✓
$24 = 12{,}5(R + r)$
$24 = V_{ext} + V_r$
$24 = 20 + Ir$
$24 = 20 + 12{,}5r$ ✓
$r = 0{,}32\ \Omega$ ✓
(5)

3.2.4. Device Z is a voltmeter✓
(1)

3.2.5. Device **Z** should be a voltmeter (or a device with very high resistance) because it has a very high resistance✓ and will draw very little current. ✓The current through **X** and **Y** will remain the same hence the device can operate as rated.

(2)

[22]

Question 4

4.1.1. Ensure that the wires have:
The same length.✓
The same thickness/cross-sectional area ✓ (2)

4.1.2. Wire **A (**Resistor A) A ✓

- Accept any correct coordinates chosen from the graph

$R = \frac{V}{I}$ ✓
$R_A = \frac{4{,}4 ✓}{0{,}4 ✓}$
$R_A = 11\ \Omega$ ✓

$R_B = \frac{2{,}2 ✓}{0{,}4 ✓}$
$R_B = 5{,}5\ \Omega$ ✓

$E = I^2 R\Delta t$ ✓

For the same time and current, the heating in A will be higher because its resistance is higher than that of B. ✓
(8)

4.2.

4.2.1. $R = \frac{V}{I}$

$11 = \frac{V}{0{,}2}$ ✓

$V = 2{,}2\ V$ ✓

$I_{5,5} = \frac{2{,}2}{5{,}5}$

$I_{5,5} = 0{,}4\ A$ ✓
(3)

4.2.2. $I_{tot} = 0{,}4 + 0{,}2$ ✓

$I_{tot} = 0{,}6\ A$

$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓

$\frac{1}{R_p} = \frac{1}{11} + \frac{1}{5{,}5}$ ✓

$R_p = 3{,}67\ \Omega$

$R_{tot} = R_p + R_A$

$R_{tot} = 3{,}67 + 11$ ✓

$R_{tot} = 14{,}67\ \Omega$

$\varepsilon = I(R + r)$ ✓

$9 = 0{,}6(14{,}67 + r)$ ✓

$r = 0{,}33\ \Omega$ ✓
(7)

4.2.3. Decrease ✓
The total resistance increases ✓
(2)

[22]

Question 5

5.1. The potential difference across a conductor is directly proportional to the current in the conductor at constant temperature. (provided temperature

and all other physical conditions are constant)✓✓
(2)

5.2. $R = \frac{V}{I}$✓
$V_8 = (0{,}5)(8)$✓
$V_8 = 4\ V$

$V_8 = V_{16}$
$\therefore V_{16} = 4\ V$

$I_{16} = \frac{V}{R}$
$I_{16} = \frac{4}{16}$
$I_{16} = 0{,}25\ A$

$I_{tot} = (0{,}5 + 0{,}25)$✓
$I_{tot} = 0{,}75\ A$✓ (4)

5.3. $V_{20\Omega} = IR$
$V_{20\Omega} = (0{,}75)(20)$✓
$V_{20\Omega} = 15\ V$

$V_{tot} = 15 + 4$✓
$V_{tot} = 19\ V$

$P = VI$ ✓
$12 = 19I$ ✓
$I_R = A_2 = 0{,}63\ A$ ✓ (5)

5.4. $\varepsilon = I(R + r)$✓
$\varepsilon = IR + Ir$
$\varepsilon = 19 + (0{,}75 + 0{,}63)(1)$✓
$\varepsilon = 20{,}38\ V$ ✓ (3)

[14]

Question 6

6.1.1. $R = \frac{V}{I}$✓
$(4 + 8) = \frac{V}{0{,}2}$✓
$V = 2{,}4\ V$ ✓ (3)

6.1.2. **Positive marking from 6.1.1**
$V = IR$

$2,4 = I_2(2)$ ✓
$I_2 = 1,2\ A$ ✓

$I_{tot} = I_2 + 0,2$ ✓
$I_{tot} = 1,4\ A$ ✓ (4)

6.1.3. $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$ ✓
$\frac{1}{R_p} = \frac{1}{12} + \frac{1}{2}$
$R_p = 1,72\ \Omega$ ✓

$\varepsilon = I(R + r)$ ✓
$\varepsilon = 1,4(1,72 + 0,5)$ ✓
$\varepsilon = 3,11\ V$ ✓
(5)

6.2. Removing the 2 Ω resistor increases the total resistance of the circuit. ✓ Thus the total current decreases, decreasing the V_{int} ✓. Therefore the voltmeter reading increases. V✓
(3)

[15]