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GAUTENG PROVINCE

EDUCATION

REPUBLIC OF SOUTH AFRICA

GRADE 12

SUBJECT: PHYSICAL SCIENCE

TERM 01

TEACHER GUIDE :MOMENTUM

SESSION 1

1. DEFINITIONS IN THIS TOPIC MUST BE GIVEN TO LEARNERS AT THE BEGINNING OF THE TOPIC AND SHOULD BE LEARNED :
 - MOMENTUM
 - IMPULSE
 - NEWTONS SECOND LAW IN TERMS OF MOMENTUM
 - STATE CONSERVATION OF PRINCIPLE OF LINEAR MOMENTUM
2. CONVERSIONS SHOULD BE EMPHASISED BEFORE CALCULATIONS i.e. **MASS IN (kg), VELOCITY IN m.s^{-1} , FORCE IN NEWTON (N)**
3. LEARNERS MUST BE EXPOSED TO THE FOLLOWING CALCULATIONS
 - CALCULATION OF BOTH INITIAL AND FINAL MOMENTUM SEPARATELY
 - CALCULATION OF CHANGE IN MOMENTUM-EMPHASIZE THE CHOICE OF DIRECTIONS AT ALL TIMES EVEN IF THE CHANGE WILL BE IN THE SAME DIRECTION.
 - CONSERVATION OF LINEAR MOMENTUM-LEARNERS NEED TO KNOW THAT NO EQUATION WILL BE GIVEN IN THE FORMULAR SHEET.

$$\sum p \text{ (before collision)} = \sum p \text{ (after collision)} \quad [\Sigma \text{ MEANS THE SUM/TOTAL/NET}]$$

$$m_1 v_{i1} + m_2 v_{i2} = m_1 v_{f1} + m_2 v_{f2}$$

$$(m_1 + m_2) v_i = m_1 v_{f1} + m_2 v_{f2}$$

$$m_1 v_{i1} + m_2 v_{i2} = (m_1 + m_2) v_f$$

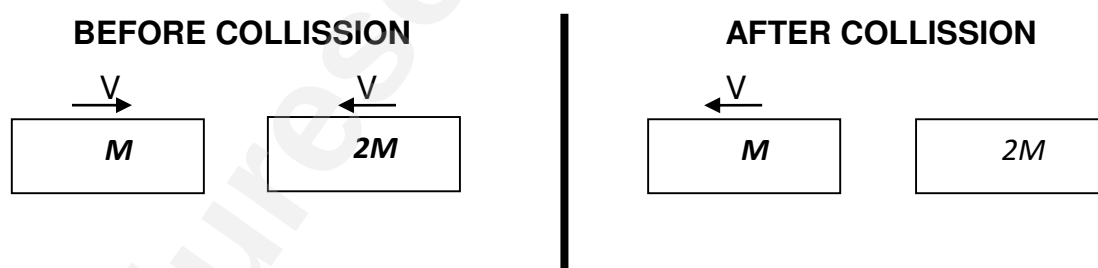
- CALCULATIONS TO PROOF THAT COLLISIONS ARE ELASTIC OR INELASTIC **[CALCULATE TOTAL KINETIC ENERGY BEFORE COLLISION THEN TOTAL KINETIC ENERGY AFTER COLLISION, AND COMPARE THE ANSWERS]**
*****NB FOR ELASTIC COLLISION THE TOTAL KINETIC ENERGY BEFORE = TOTAL KINETIC ENERGY AFTER COLLISION, AND FOR INELASTIC COLLISION, THE ANSWERS ARE NOT THE SAME]**
- CALCULATIONS OF IMPULSE **[$F_{\text{NET}} \Delta t = \Delta P$]**
*****NB: LEARNERS SHOULD ALSO BE ABLE TO CALCULATE F_{NET} FROM THIS EQUATION AND ALSO TO EXPLAIN THE RELATIONSHIP BETWEEN F_{NET} AND Δt**
LEARNERS SHOULD BE ABLE TO DRAW GRAPHS REPRESENTING THE RELATIONSHIP BETWEEN F_{NET} AND Δt

MOMENTUM QUESTIONS MAY INCLUDE SCENARIOS LIKE : COLLIDING BALLS , CARS COLLIDING WITH EACH OTHER, A PENDULUM, SKATEBOARDS WITH A PERSON ON, A GUN RECOILING OR A BOAT ETC.

MULTIPLE CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.5)

- 1.1 Net force is the measure of the...
- change in energy
 - rate of change in energy
 - change in momentum
 - rate of change in momentum
- 1.2 During a collision an inflated air bag in a car decreases the net force that would have acted on the driver of the car. This is because the time interval over which the net force acts on the driver ... for the same momentum change.
- is zero
 - decreases
 - increases
 - remains constant
- 1.3 An object of mass m moving at velocity v collides head-on with an object of mass $2m$ moving in the opposite direction at velocity v . Immediately after the collision the smaller mass moves at velocity v in the opposite direction and the larger mass is brought to rest. Refer to the diagram below



Ignore the effect of friction. Which of the following is correct:

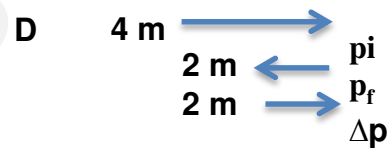
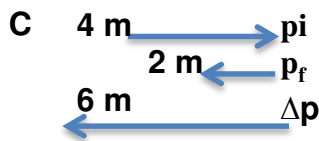
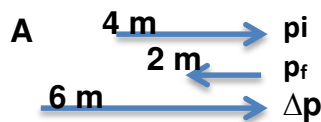
	MOMENTUM	MECHANICAL ENERGY
A	Conserved	conserved
B	Not conserved	conserved
C	Conserved	Not conserved
D	Not conserved	Not conserved

1.4 If the momentum of an object is doubled, then its kinetic energy is...

- A. halved.
- B. doubled.
- C. three times greater.
- D. four times greater.

1.5 A ball of mass m , moving horizontally to the right, strikes the wall with a velocity of $4 \text{ m}\cdot\text{s}^{-1}$. The ball rebounds in the opposite direction with the velocity of $2 \text{ m}\cdot\text{s}^{-1}$.

Which one of the following correctly represents the momentum vectors of the initial momentum (p_i), the final momentum (p_f) and the change in momentum (Δp) of the ball in $\text{kg}\cdot\text{m}\cdot\text{s}^{-1}$

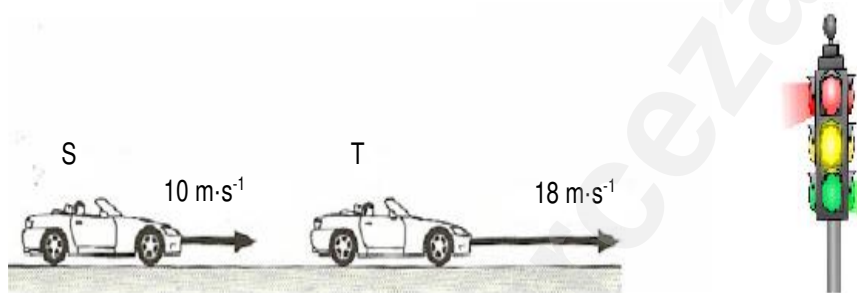


[10]

STRUCTURED QUESTIONS

QUESTION 1

Two cars S and T travelling on a straight road approach a robot at velocities of $10\text{ m}\cdot\text{s}^{-1}$ East and $18\text{ m}\cdot\text{s}^{-1}$ East respectively as shown in the sketch. Ignore the effect of friction. Car T suddenly stops and car S collides with car T. After the collision the two cars move off together as a unit. The combined mass of each car with the driver is 1500 kg



1.1.1 Calculate the speed of the two cars immediately after the collision. **$[5\text{ m}\cdot\text{s}^{-1}]$** (4)

Research has shown that forces greater than $85\,000\text{ N}$ during collisions may cause fatal injuries. The collision described above lasts for $0,08\text{ s}$.

1.1.2 Determine, by means of calculations, whether the collision above could result in a fatal injury. **$[93\,750\text{ N}]$** (4)

The cars have crumple zones, seat belts, air bags and padded interiors that can reduce the chance of death or serious injury during accidents.

1.1.3 Use principles of Physics to explain how air bags can reduce the risk of injury or death. (3)

[11]

QUESTION 2

2.1 Two boys, each of mass m , are standing at the back of a flatbed trolley of mass 4 m. The trolley is at rest on a frictionless horizontal surface.

The boys jump off simultaneously at one end of the trolley with a horizontal velocity of $2 \text{ m}\cdot\text{s}^{-1}$. The trolley moves in the opposite direction.

2.1.1 Write down the *principle of conservation of linear momentum* in words. (2)

2.1.2 Calculate the final velocity of the trolley. [$1\text{m}\cdot\text{s}^{-1}$] (5)

2.1.3 The two boys jump off the trolley one at a time. How will the velocity of the trolley compare to that calculated in QUESTION 2.2?

Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

[8]

QUESTION 3

3.1 A girl of mass 40 kg is given a lift on the back of a 10 kg bicycle by a boy of mass 30 kg. They travel at a constant speed of $2,5 \text{ m}\cdot\text{s}^{-1}$.

The girl wishes to get off the back of the bicycle while it is still moving.

3.1.1 She knows that if she just puts her feet on the ground and stands up, she is likely to fall over. Use the law in physics to explain why she falls over. (2)

So instead, she pushes herself off the back of the bicycle by pushing in the direction of the movement on the bicycle frame with her hands, so that she lands on the ground with zero horizontal velocity.

3.1.2 State the law of conservation of momentum in words. (2)

3.1.3 Calculate the magnitude of the velocity of the bicycle and the boy immediately after the girl has left the bicycle. [$5 \text{ m}\cdot\text{s}^{-1}$] (4)

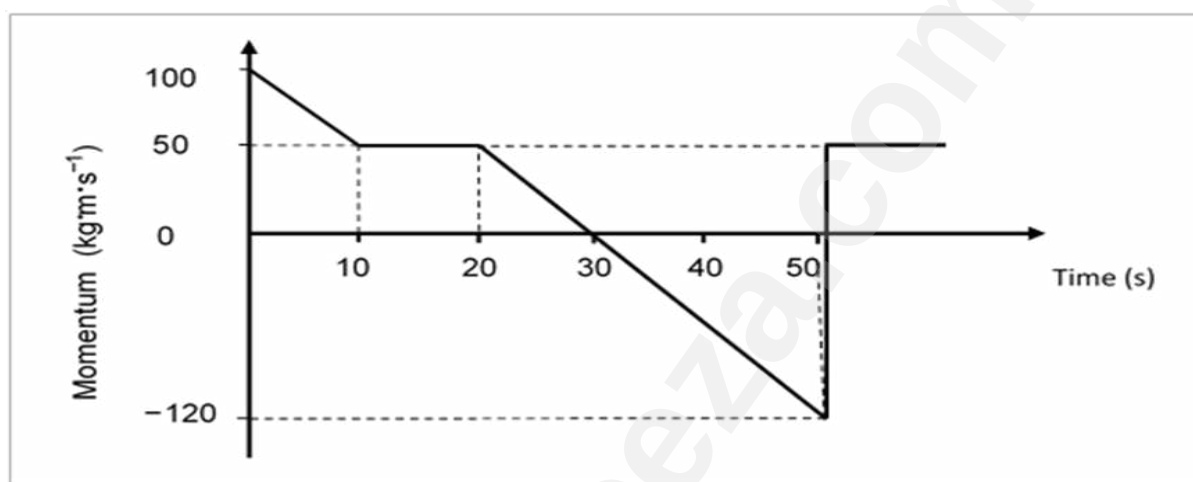
3.1.4 Calculate the total kinetic energy of the system (bicycle and both children) before and after the girl gets off. [250J, 500J] (4)

Explain the reason for any difference. (1)

[13]

QUESTION 4

4.1 The momentum versus time graph of object **A**, originally moving horizontally EAST, is shown



4.1.1 Write down the definition of *momentum* in words. (2)

4.1.2 The net force acting on object **A** is zero between $t = 10$ s and $t = 20$ s. Use the graph and a relevant equation to explain why this statement is TRUE.

(2)

4.1.3 Calculate the magnitude of the impulse that object **A** experiences between $t = 20$ s and $t = 50$ s. [170N.s] (3)

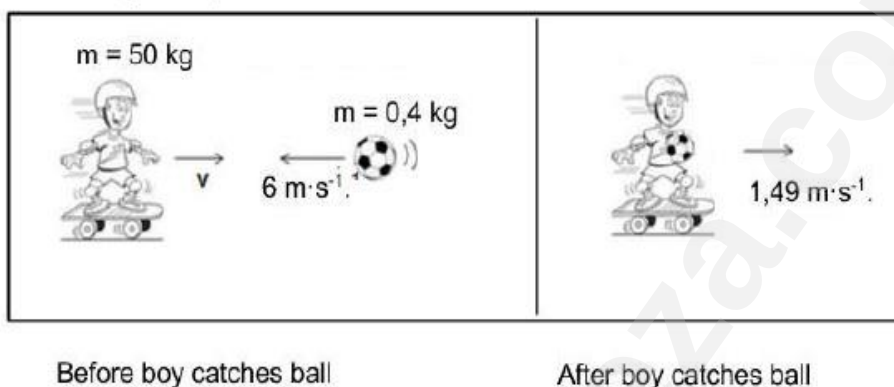
4.1.4 At $t = 50$ s, object **A** collides with another object, **B**, which has a momentum of $70 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$ EAST. Use the information from the graph and the relevant principle to calculate the momentum of object **B** after the collision. [100 kg.m.s⁻¹]

(5)

[12]

QUESTION 5

A boy on a skateboard moves to the right at constant velocity. The joint mass of the boy and skateboard is 50 kg. He catches a ball with of mass 0,4 kg that is travelling horizontally to the left at a velocity of $6 \text{ m} \cdot \text{s}^{-1}$. After the boy catches the ball, they both move to the right at $1,49 \text{ m} \cdot \text{s}^{-1}$.



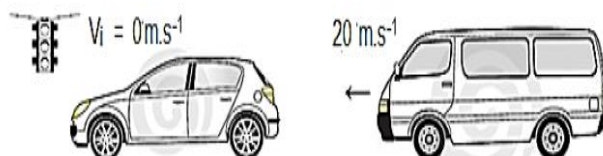
- 5.1 Define the term impulse. (2)
- 5.2 Calculate the magnitude of the average force that the boy exerts on the ball when he catches it, if he and the ball exert a force for a period of 0,1 s on each other. **[29,96N]** (3)
- 5.3 Write down the Principle of Conservation of Momentum. (2)
- 5.4 Calculate the magnitude of the velocity v of the boy before he catches the ball. **[1,55m·s⁻¹]** (3)
- 5.5 Prove with the necessary calculation that this is an inelastic collision. **[\sum E_{k_b} = 67,26J; \sum E_{k_a} = 55,95J] Inelastic collision** (5)

[15]

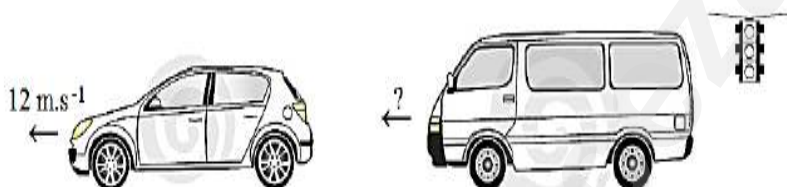
QUESTION 6

A car of mass 1 500 kg is stationary at a traffic light. It is hit from behind by a minibus of mass 2 000 kg travelling at a speed of $20 \text{ m}\cdot\text{s}^{-1}$. Immediately after the collision the car moves forward at $12 \text{ m}\cdot\text{s}^{-1}$.

BEFORE



AFTER



6.1 State the LAW OF CONSERVATION OF LINEAR MOMENTUM in words. (2)

6.2 Calculate the speed of the minibus immediately after the collision. [**$11 \text{ m}\cdot\text{s}^{-1}$**] (4)

6.3 The driver of the minibus is NOT wearing a seatbelt.
Describe the motion that the driver undergoes immediately after the collision. (1)

6.4 State the law of physics which can be used to explain your answer about the motion of the driver in QUESTION 6.3. (2)

[9]

QUESTION 7

A 0,5 kg soccer ball, moving horizontally at $6 \text{ m}\cdot\text{s}^{-1}$, collides with a soccer player's head and is headed directly back at $9 \text{ m}\cdot\text{s}^{-1}$. The ball is in contact with the player's head for 0,02 s. Ignore the effects of friction.

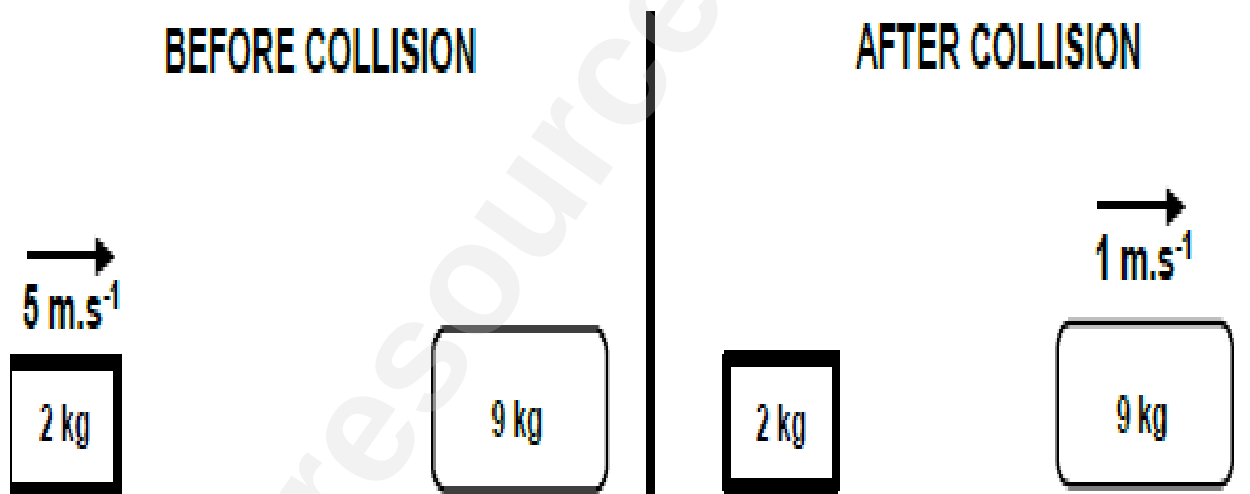
7.1 What is the relationship between impulse and change in momentum? (1)

7.2 Is the total momentum conserved during this collision?
Provide a reason for your answer. (2)

- 7.3 Calculate the magnitude of the average force exerted by the soccer player's head on the ball. **[375N]** (4)
- 7.4 A second ball is pumped to its maximum volume so that it cannot be compressed. Assume that the two balls have the same mass. If the second ball strikes the soccer player's head with a velocity of $6 \text{ m}\cdot\text{s}^{-1}$, will the force exerted by the soccer player's head on the ball be greater than, less than or equal to the force calculated in question 7.3. Give a reason for your answer. (3)
[10]

QUESTION 8

A wooden block of mass 2 kg , moving at a velocity of $5 \text{ m}\cdot\text{s}^{-1}$, collides with a crate of mass 9 kg resting on a flat horizontal surface as shown in the diagram below. After the collision, the crate moves to the right at $1 \text{ m}\cdot\text{s}^{-1}$. Ignore the effects of friction.

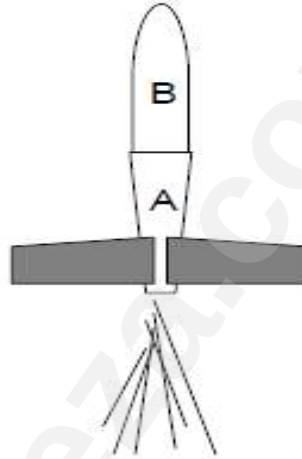


- 8.1 Write down the principle of conservation of linear momentum in words. (2)
- 8.2 Calculate the magnitude of the velocity of the wooden block immediately after the collision. **[$0,5 \text{ m}\cdot\text{s}^{-1}$]** (4)
- 8.3 If the collision lasts $0,6$ seconds, calculate the force the wooden block exerts on the crate during the collision. **[15N]** (4)

[10]

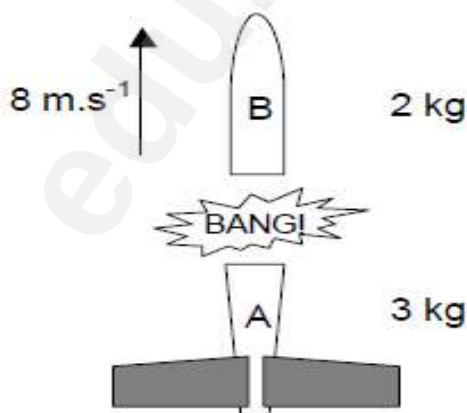
QUESTION 9

Hendrik is an amateur rocket builder. He launches a two-stage rocket as shown below. Section A (stage 1) contains the rocket engine and fuel. Section B (stage 2) has a mass of 2 kg.



9.1 Hendrik says that Newton's Third Law of Motion is used to explain why the rocket moves upwards. Identify one action-reaction pair of forces involved with the launching. (2)

At a certain height, when the rocket has a velocity of 5 m.s^{-1} , the last fuel is used up and section A then has a mass of 3 kg. To get section B even higher, a small explosion separates section B from section A at this point and increases the upward velocity of section B to 8 m.s^{-1} .



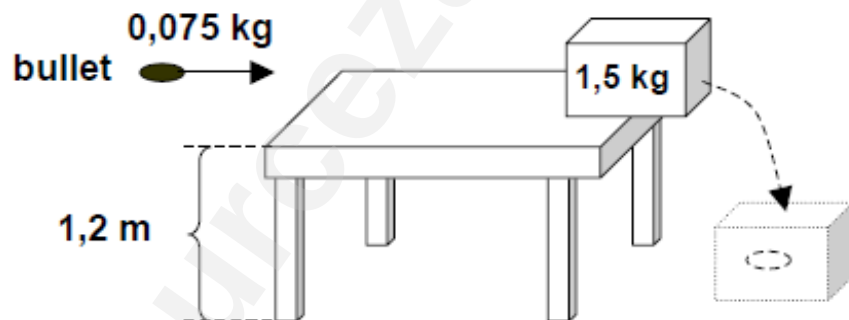
9.2 State, in words, the principle of conservation of momentum. (3)

9.3 Calculate the velocity of section A after the explosion. [$3 \text{ m}\cdot\text{s}^{-1}$] (6)

[11]

QUESTION 10

A $1,5 \text{ kg}$ block of wood is placed on the edge of a table $1,2 \text{ m}$ above the floor. The block is struck by a bullet, mass $0,075 \text{ kg}$, moving at an unknown, horizontal velocity. After the impact, the bullet is embedded in the block, which falls to the floor. The block strikes the floor with a speed of $8 \text{ m}\cdot\text{s}^{-1}$. Ignore all types of friction.



Calculate:

10.1 Write down the principle of conservation of linear momentum words. (2)

10.2 The magnitude of the velocity with which the bullet strikes the block. (7)
[$132,72 \text{ m}\cdot\text{s}^{-1}$]

10.3 The magnitude of the impulse of the bullet during the impact. [$9,48 \text{ N}\cdot\text{s}$] (5)

[14]



GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2016

GRADE 12

SUBJECT: PHYSICAL SCIENCE

SESSION 1

MEMORANDUM- MOMENTUM

MULTIPLE CHOICE

- 1.1 D $F_{NET} \cdot \Delta t = \Delta P \Rightarrow F_{NET} = \frac{\Delta P}{\Delta t}$
- 1.2 C $\downarrow F_{NET} \propto \frac{1}{\Delta t \uparrow} \quad \Delta P = CONSTANT$
- 1.3 C Momentum is always conserved. Total kinetic energy of the system before collision is greater than total kinetic energy after collision because the kinetic energy of the larger mass after collision = 0J, it comes to rest , Ek = 0J]
- 1.4 D $p = mv \Rightarrow 2p = m(2v)$ [mass is constant SAME OBJECT]
 $E_k = \frac{1}{2}mv^2 \Rightarrow E_k = \frac{1}{2}m(2v)^2 \Rightarrow E_k = 4(\frac{1}{2}mv^2)$
- 1.5 C $\Delta p = p_f - p_i$ [$p_i = 4m$, $p_f = 2m$: if you choose one direction as + and the other as + then $\Delta p = +2 - (-4) = 6m$ OR $\Delta p = -2 - (4) = -6$]

STRUCTURED QUESTIONS

QUESTION 1

$$\begin{aligned}
 1.1 \quad \Sigma p_i &= \Sigma p_f \\
 m_1 v_{i1} + m_2 v_{i2} &= (m_1 + m_2) v_f \quad \checkmark \\
 (1\,500)(10) + (1\,500)(0) &\checkmark = (3\,000) v_f \quad \checkmark \\
 15\,000 &= 3\,000 v_f \\
 v_f &= \frac{15\,000}{3\,000} = 5 \text{ m}\cdot\text{s}^{-1} \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 1.2 \quad F &= \frac{m(v_f - v_i)}{\Delta t} \quad \checkmark \\
 &= \frac{(1\,500)(5 - 0)}{0,08} \quad \checkmark \\
 &= 93\,750 \text{ N} \quad \checkmark
 \end{aligned}$$

Yes, it can result in a fatal injury because the force is greater than 85 000 N. $\checkmark$

- 1.3 When the air bag inflates during the collision the contact time of the passenger or driver with the air bag is longer than without air bag $\checkmark$ as the air bag then takes time to deflate once the driver makes contact with the bag.
Thus the force on the passenger or driver is reduced $\checkmark$ according to the equation.
 $F_{\text{net}} = \frac{\Delta p}{\Delta t}$ $\checkmark$ because Δp is constant during the collision.

QUESTION 2

- 2.1 The total linear momentum in a closed system $\checkmark$ remains constant. $\checkmark$

$$\begin{aligned}
 2.2 \quad \Sigma p_i &= \Sigma p_f \\
 (m_1 + m_2) v_i &= m_1 v_{1f} + m_2 v_{2f} \quad \checkmark \\
 (2\,m + 4\,m)(0) &\checkmark = 2\,m(2) + 4\,m(v_{2f}) \quad \checkmark \\
 -4\,m &= 4\,m v_f
 \end{aligned}$$

$$\begin{aligned}
 v_f &= -1 \text{ m}\cdot\text{s}^{-1} \\
 &= 1 \text{ m}\cdot\text{s}^{-1} \quad \checkmark \text{ in the opposite direction to that of the boys. } \checkmark
 \end{aligned}$$

- 2.3 Equal to.

First boy jumps off : $\Sigma p_i = \Sigma p_f$

$$\begin{aligned}
 (m_1 + m_2) v_i &= m_1 v_{1f} + m_2 v_{2f} \\
 (m + 5\,m)(0) &= 1\,m(2) + 5\,m(v_{2f}) \\
 -2\,m &= 5\,m v_f \\
 v_f &= -0,4 \text{ m}\cdot\text{s}^{-1}
 \end{aligned}$$

Second boy jumps off : $\Sigma p_i = \Sigma p_f$

$$\begin{aligned}
 (m_1 + m_2) v_i &= m_1 v_{1f} + m_2 v_{2f} \\
 (m + 4\,m)(-0,4) &= 1\,m(2) + 4\,m(v_{2f}) \\
 -2\,m &= 2\,m + 4\,m v_f \\
 v_f &= -1 \text{ m}\cdot\text{s}^{-1}
 \end{aligned}$$

QUESTION 3

3.1 By Newton's First Law, her feet will come to rest on the ground but her upper body will continue to move forwards due to inertia.

3.2 Total linear momentum of a closed system remains constant in magnitude and direction.

3.3 $\Sigma p_i = \Sigma p_f$

$$(m_1 + m_2) v_{i2} = m_1 v_{f1} + m_2 v_{f2}$$

Mass of boy + mass of bicycle = m_1

$$(40 + 40)(2,5) = (40) v_{f1} + (40)(0)$$

$$200 = 40 v_{f1}$$

$$v_f = 5 \text{ m}\cdot\text{s}^{-1} \quad (\text{magnitude has no direction})$$

3.4 $E_{k \text{ before}} = \frac{1}{2} m v^2 = \frac{1}{2} (80)(2,5)^2 = 250 \text{ J}$

$$E_{k \text{ after}} = \frac{1}{2} m v^2 = \frac{1}{2} (40)(5)^2 + 0 = 500 \text{ J}$$

Increase in kinetic energy is provided by the chemical energy in the girl's muscles as she did work by pushing against the bicycle frame. This is an inelastic situation.

QUESTION 4

4.1 Momentum is the product of an object's mass and its velocity.

4.2 $\Delta p = 0$. $F_{\text{net}} = \frac{\Delta p}{\Delta t} = 0$

4.3

$$\begin{aligned} F_{\text{net}} \Delta t &= \Delta p \checkmark \\ &= p_f - p_i \\ &= -120 - 50 \checkmark \\ &= -170 \end{aligned}$$

$$F_{\text{net}} \Delta t = 170 \text{ N}\cdot\text{s} \quad \text{OR} \quad \text{kg}\cdot\text{m}\cdot\text{s}^{-1}$$

Ignore the minus sign for magnitude.

4.4 $\Sigma p_i = \Sigma p_f$

$$-120 + 70 \checkmark = 50 + p_{Bf} \checkmark$$

$$\therefore p_{Bf} = -100$$

$$\therefore p_{Bf} = 100 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} \checkmark \text{ west } \checkmark$$

QUESTION 5

5.1 The product of the resultant/net force acting on an object and the time the resultant/net force acts on the object. ✓ ✓ (2)

5.2 Right = positive

$$F_{\text{net}}\Delta t = m\Delta v = m(v_f - v_i) \checkmark \text{ (or other correct form of the equation)}$$

$$F_{\text{net}}(0,1) = 0,4[1,49 - (-6)] \checkmark$$

$$F_{\text{net}} = 29,96 \text{ N } \checkmark \quad (3)$$

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

5.4 $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v \checkmark$ (Right = positive)

$$50v_{1i} + (0,4)(-6) = 50,4(1,49) \checkmark$$

$$v_{1i} = 1,55 \text{ m}\cdot\text{s}^{-1} \checkmark \quad (3)$$

5.5 Total kinetic energy before collision:

$$\frac{1}{2} m_1v_{1i}^2 + \frac{1}{2} m_2v_{2i}^2$$

$$= (0,5)(50)(1,55)^2 + (0,5)(0,4)(-6)^2 \checkmark$$

$$= 67,26 \text{ J } \checkmark$$

Total kinetic energy after collision:

$$\frac{1}{2} (m_1 + m_2)v^2$$

$$= (0,5)(50,4)(1,49)^2 \checkmark$$

$$= 55,95 \text{ J } \checkmark$$

$E_k \text{ before} \neq E_k \text{ after} \checkmark$ therefore Inelastic collision. (5)
[15]

QUESTION 6

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

or

Total linear momentum before a collision = total linear momentum after a collision in a closed system. ✓ ✓ (2)

6.2 Consider LEFT as positive

$$\Sigma p_i = \Sigma p_f \checkmark$$

$$m_Mv_{Mi} + m_Cv_{Ci} = m_Mv_{fM} + m_Cv_{fC}$$

$$(2000)(20) + (1\,500)(0) \checkmark = (2000)(12) + 1500v_{fC} \checkmark$$

$$v_{fM} = 11 \text{ m}\cdot\text{s}^{-1} \checkmark \quad (4)$$

6.3 The driver will continue moving forward at the same velocity until the driver strikes the dashboard or windscreen. ✓ (1)

6.4 A body will remain in its state of rest or motion at constant velocity ✓ unless a non-zero resultant force acts on it. ✓ (2)

QUESTION 7

7.1 impulse EQUALS change in momentum ✓ (1)

7.2 Yes. The system is isolated / closed with no external forces acting on person and ball. ✓ ✓ (2)

7.3 Take direction towards player as positive

$$F_{\text{net}}\Delta t = m\Delta v$$

$$= mv_f - mvi \checkmark$$

$$F_{\text{net}}(0,02) = (0,5)((9) - (-6)) \checkmark = 7,5$$

$$F_{\text{net}} = 375 \text{ N} \checkmark$$

Take direction towards player as negative

$$F_{\text{net}}\Delta t = m\Delta v = mv_f - mvi \checkmark$$

$$F_{\text{net}}(0,02) \checkmark = (0,5)((-9) - (6)) \checkmark = -7,5$$

$$F_{\text{net}} = -375 \text{ N}$$

$$F_{\text{net}} = 375 \text{ N} \checkmark$$

(4)

7.4 Greater ✓ r. The change in momentum for the ball will be the same but the time of contact will be smaller. ✓ ✓ (3)

[10]

QUESTION 8

8.1 The total (linear) momentum remains constant/is conserved □ in an isolated/a closed system/the absence of external forces. (2)

8.2 To the right as positive

$$\Sigma p_{\text{before}} = \Sigma p_{\text{after}}$$

$$(2)(5) + (9)(0) = (2)v_{f1} + (9)(1)$$

$$\therefore v_{f1} = 0,5 \text{ m.s}^{-1} \text{ right}$$

To the right as negative

$$\Sigma p_{\text{before}} = \Sigma p_{\text{after}}$$

$$(2)(-5) + (9)(0) = (2)v_{f1} + (9)(-1)$$

$$v_{f1} = -0,5 \text{ m.s}^{-1}$$

$$\therefore v_{f1} = 0,5 \text{ m.s}^{-1} \text{ right}$$

8.3 OPTION 1:(Wooden block)

$$F_{\text{net}}\Delta t = m\Delta v \text{ OR } F_{\text{net}}\Delta t = \Delta p$$

$$F_{\text{net}}(0,6) = 2(0,5 - 5)$$

$$F_{\text{net}} = -15 \text{ N} \therefore$$

$$\text{magnitude of } F_{\text{net}} = 15 \text{ N}$$

OPTION 2: (Crate)

$$F_{\text{net}}\Delta t = m\Delta v \text{ OR } F_{\text{net}}\Delta t = \Delta p$$

$$F_{\text{net}}(0,6) = 9(1 - 0)$$

$$F_{\text{net}} = 15 \text{ N}$$

$\therefore$ magnitude of $F_{\text{net}} = 15 \text{ N}$

QUESTION 9

9.1 F_{earth} on rocket and F_{rocket} on earth OR F_{escaping} gas on rocket and F_{rocket} on escaping gas (**any one pair**)

Gravitational force of earth on rocket and F_{rocket} on earth

9.2 The total linear momentum in an isolated system remains constant

(Conserved in magnitude and direction)

OR

In an isolated system (if there are no external forces acting) the total momentum before a collision is equal to the total momentum after collision

9.3 Upwards positive

$$\Sigma p_{\text{before}} = \Sigma p_{\text{after}}$$

$$Mu = m_1v_1 + m_2v_2$$

$$[(3+2)5] = (2)(8) + (3)v_2$$

$$v_2 = 3 \text{ m.s}^{-1} \text{ upwards}$$

Down Positive

$$\Sigma p \text{ (before)} = \Sigma p \text{ (after)}$$

$$(m_1+m_2)v_i = m_1v_1 + m_2v_2$$

$$[(3+2)(-5)] = (2)(-8) + (3)v_2$$

$$v_2 = -3 \text{ m.s}^{-1}$$

$$v_2 = 3 \text{ m.s}^{-1} \text{ upwards}$$

QUESTION 10

10.1 The total linear momentum in an isolated system remains constant (Conserved in magnitude and direction) **OR** In an isolated system (if there are no external forces acting) the total momentum before a collision is equal to the total momentum after Collision

10.2

$$\Sigma p_i = \Sigma p_f$$

$$m_1v_{i1} + m_2v_{i2} = (m_1+m_2)v_f$$

$$(0,075)v_{i1} + (0,825)(0) = (1,575)(6,32)$$

$$v_{i1} = 132,75 \text{ m.s}^{-1}$$

10.3

$$\text{impulse} = F_{\text{net}} = \Delta p$$

$$= mv_f - mv_i$$

$$= (0,075)(6,32 - 132,72)$$

$$= -9,48 \text{ N.s}$$

$$= 9,48 \text{ N.s opposite direction.}$$

[14]



GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2016

GRADE 12

PHYSICAL SCIENCE

TERM 01

LEARNERS GUIDE-VERTICAL PROJECTILES

SESSION 2

SESSION	VERTICAL PROJECTILE MOTION
2	Definition of : <i>Free falling</i> objects
	<i>Acceleration due to gravity always downwards near earth's surface at $g = (9,8 \text{ m.s}^{-2})$</i>
	Defination of : <i>Terminal velocity</i> , Air resistance (or air friction) have same magnitude as the weight of the object. IMPORTANT: • Provided there is no friction, the total energy of a free falling body remains constant. • Concepts: acceleration, velocity, change in position are all vectors (direction is indicated) • "Drop" means $v_i = 0 \text{ m.s}^{-1}$ (starting from rest)
	Equations : $v_f = v_i + a\Delta t$ $v_f^2 = v_i^2 + 2a\Delta y$ $\Delta y = v_i\Delta t + \frac{1}{2} a\Delta t^2$ $\Delta y = \frac{v_i + v_f}{2} \Delta t$
	GRAPHS OF MOTION: <i>velocity vs time graph,</i> <i>displacement vs time graph and</i> <i>acceleration vs time graph</i>

} acceleration is uniform

MULTIPLE CHOICE QUESTIONS

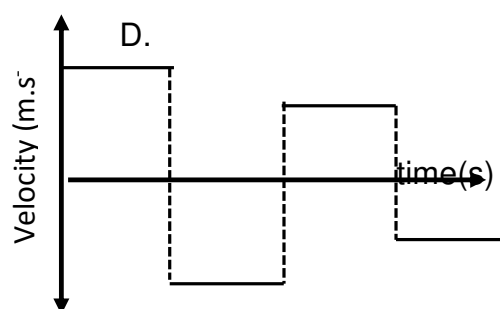
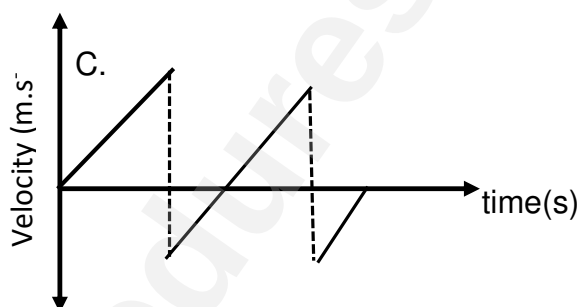
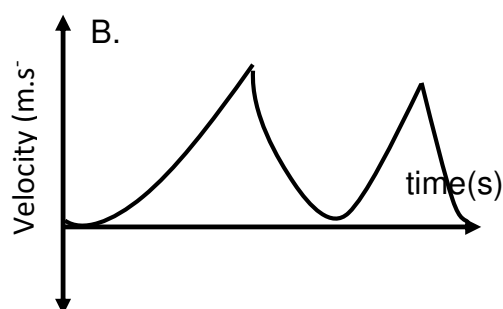
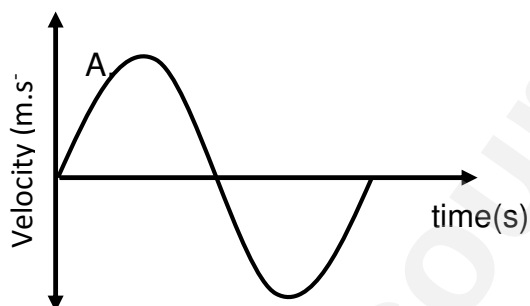
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.7)

- 1.1 A ball is thrown vertically upwards into the air. Ignore the effects of friction.

The NET FORCE acting on the ball when the ball is at its highest point is ...

- A. zero.
- B. equal to the weight of the ball.
- C. less than the weight of the ball.
- D. greater than the weight of the ball.

- 1.2 A ball is released from rest from a certain height above the floor and bounces off the floor a number of times. Ignore the effects of air resistance. Which ONE of the following velocity-time graphs best represents the motion of the ball?



- 1.3 If air resistance is negligible, the total mechanical energy of a free-falling body

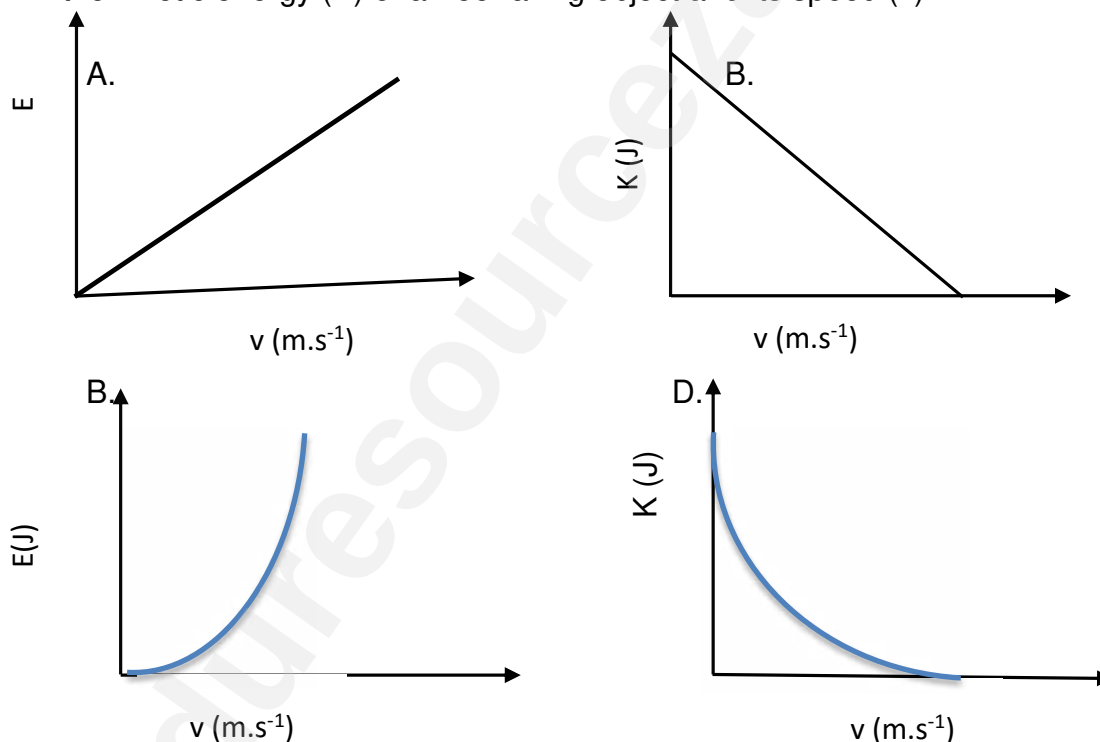
...

- A. remains constant.
- B. becomes zero.
- C. increases.
- D. decreases.

- 1.4 An object is thrown vertically upwards. Which ONE of the following regarding the object's velocity and acceleration at the highest point of its motion is CORRECT? Ignore the effects of friction.

	VELOCITY	ACCELERATION
A.	Zero	zero
B.	Zero	upwards
C.	maximum	zero
D.	zero	Downwards

- 1.5 Which ONE of the graphs below correctly represents the relationship between the kinetic energy (K) of a free-falling object and its speed (v)?



- 1.6 A ball is thrown vertically upwards. Which ONE of the following physical quantities has a non-zero value at the instant the ball changes direction?

- A. Acceleration
- B. Kinetic energy
- C. Momentum
- D. Velocity

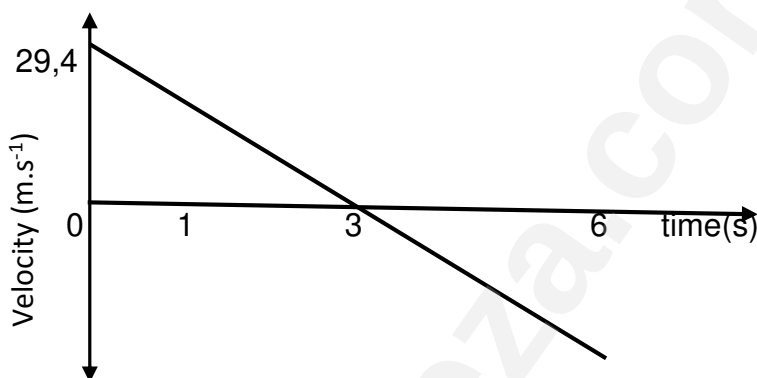
1.7 A student throws a tennis ball vertically upwards into the air. She catches the ball 10 s later at the same height from which she threw it. Which ONE of the following statements is INCORRECT with regards to the above situation?

- A. The velocity of the ball decreases as it moves upwards.
- B. The velocity of the ball is zero when it reaches its maximum height.
- C. The ball returns to the student's hands with the same speed with which she threw the ball upwards.
- D. The acceleration of the ball as it goes upwards is equal to the acceleration of the ball as it falls downwards but in the opposite direction

STRUCTURED QUESTIONS

QUESTION 1

A man fires a projectile X vertically upwards at a velocity of $29,4 \text{ m}\cdot\text{s}^{-1}$ from the EDGE of a cliff of height 100 m. After some time the projectile lands on the ground below the cliff. The velocity-time graph below (NOT DRAWN TO SCALE) represents the motion of projectile X. (Ignore the effects of friction.)



1.1 Use the graph to determine the time that the projectile takes to reach its maximum height. (*calculation not required.*) (1)

1.2 Calculate the maximum height that projectile X reaches above the ground.

[144.1m] (4)

1.3 Sketch the position-time graph for projectile X for the period $t = 0 \text{ s}$ to $t = 6 \text{ s}$.
USE THE EDGE OF THE CLIFF AS ZERO OF POSITION.

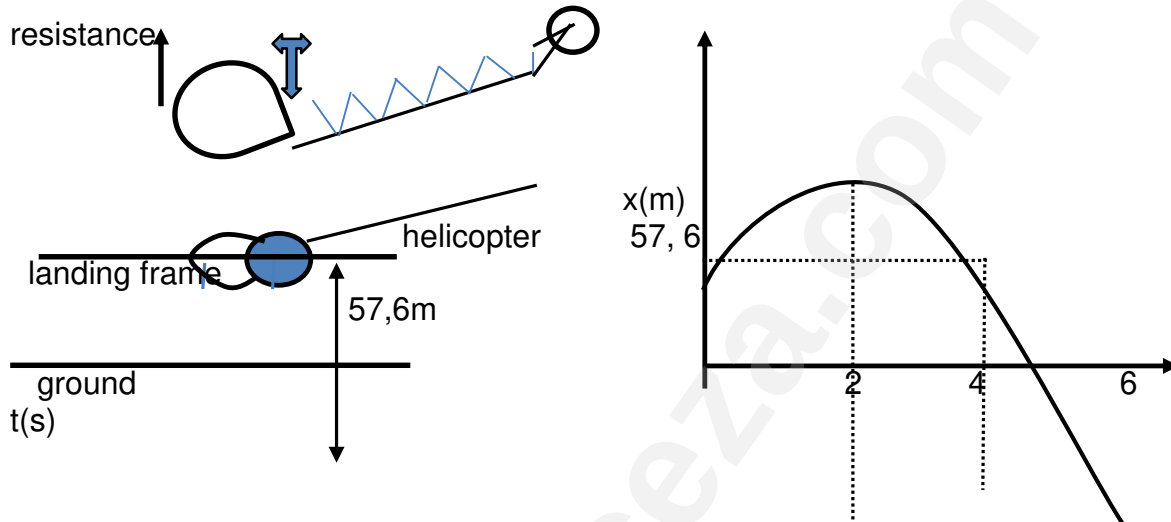
Indicate the following on the graph:

- The time when projectile X reaches its maximum height
 - The time when projectile X reaches the edge of the cliff
- (4)

1.4 One second (1 s) after projectile X is fired, the man's friend fires a second projectile Y upwards at a velocity of $49 \text{ m}\cdot\text{s}^{-1}$ FROM THE GROUND BELOW THE CLIFF. The first projectile, X, passes projectile Y 5,23 s after projectile X is fired. (Ignore the effects of friction.) Calculate the velocity of projectile X at the instant it passes projectile Y. **[21.85m.s⁻¹]** (5)

QUESTION 2

A helicopter rises vertically with a constant velocity and when it is 57,6 m above the ground, a 2 kg object falls off its landing frame. The trajectory of the falling 2 kg object is shown on the left hand diagram. The position – time graph represents the motion of the object the moment it is released to when it strikes the ground. Ignore air resistance



2.1 Calculate the vertical velocity of the helicopter at the moment when the object fell off. (4)

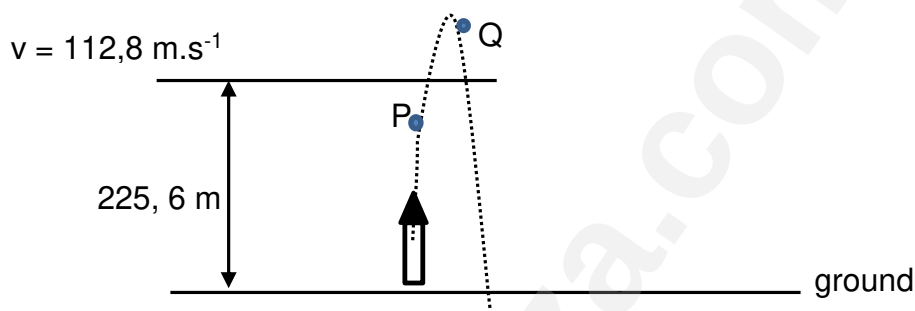
2.2 Draw a sketch graph of the velocity vs time for the motion of the object that fell off. **Show the following in the sketch**

- the initial velocity of the ball,
- the time the object reaches a maximum position
- the time the object hit the ground

(3)

QUESTION 3

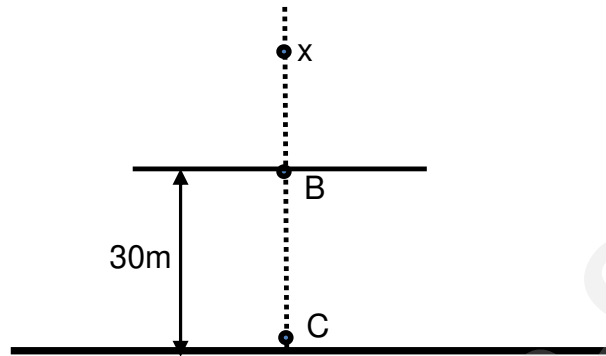
A stationary rocket on the ground is launched vertically upwards. After 4 s, the rocket's fuel is used up and it is 225,6 m above the ground. At this instant the velocity of the rocket is $112,8 \text{ m}\cdot\text{s}^{-1}$. The diagram below shows the path followed by the rocket. Ignore the effects of air friction.



- 3.1 Write down the direction of the acceleration of the rocket at point:
- 3.1.1 P (1)
- 3.1.2 Q (1)
- 3.2 At which point (P or Q) is the rocket in free fall? Give a reason for the answer. (2)
- 3.3 TAKING UPWARD MOTION AS POSITIVE, USE EQUATIONS OF MOTION to calculate the time taken from the moment the rocket is launched until it strikes the ground. [28.87s] (6)
- 3.4 Sketch a velocity versus time graph for the motion of the rocket from the moment it runs out of fuel until it strikes the ground. Take the time when the rocket runs out of fuel as $t = 0 \text{ s}$. **Indicate the following values on the graph:**
- Velocity of the rocket when it runs out of fuel
 - Time at which the rocket strikes the ground (5)

QUESTION 4

An object is from rest from a point X, above the ground as shown in the diagram below. It travels the last 30m (BC) in 1,5 s before hitting the ground . Ignore the effects of air friction.



4.1 Write down the type of motion described above (1)

4.2 Calculate the:

4.2.1 Magnitude of the velocity of the object at point B [12,65m.s⁻¹] (4)

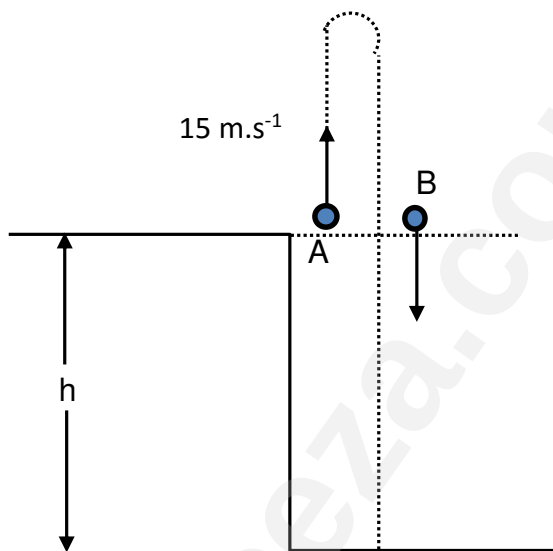
4.2.2 Height of point X above the ground [38,16m] (4)

After hitting the ground, the object bounces once and then comes to rest on the ground.

4.3 Sketch an acceleration – time graph for the entire motion of the object (3)

QUESTION 5

A ball, A, is thrown vertically upward from a height, h , with a speed of $15 \text{ m}\cdot\text{s}^{-1}$. AT THE SAME INSTANT, a second identical ball, B, is dropped from the same height as ball A as shown in the diagram below. Both balls undergo free fall and eventually hit the ground.



- 5.1 Explain the term free fall. (2)
- 5.2 Calculate the time it takes for ball A to return to its starting point. **[3.06s]** (4)
- 5.3 Calculate the distance between ball A and ball B when ball A is at its maximum height. **[22.95m]** (7)
- 5.4 Sketch a velocity-time graph for the motion of ball A from the time it is projected until it hits the ground.

Clearly show the following on your graph:

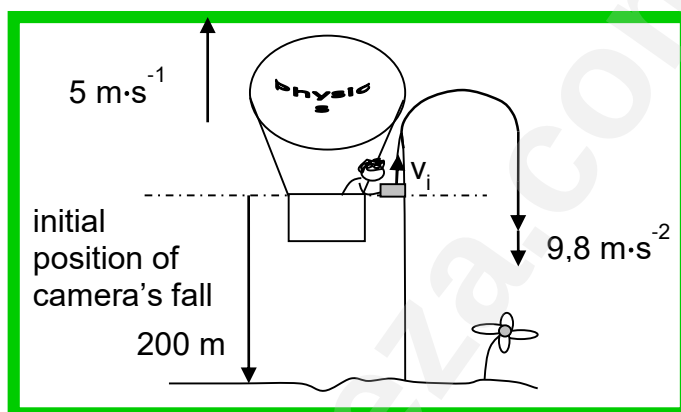
- The initial velocity
- The time it takes to reach its maximum height
- The time it takes to return to its starting point (4)

[17]

QUESTION 6

A hot-air balloon is rising with a constant velocity of $5 \text{ m}\cdot\text{s}^{-1}$ upwards. A photographer is standing in the basket. He leans over the side and takes photos with his camera.

When the basket is 200 m above the ground, the camera accidentally falls off his hand.



6.1 From the moment the camera falls from the photographer's hand determine the magnitude of:

6.1.1 the initial velocity

6.1.2 the acceleration of the camera (2)

6.2 Calculate the total time the camera will take to reach the ground. **[6.92s]** (4)

6.3 Calculate the distance between photographer's hand and the camera 3 s after the camera fell off his hand. **[44.1m]** (4)

[10]

QUESTION 7

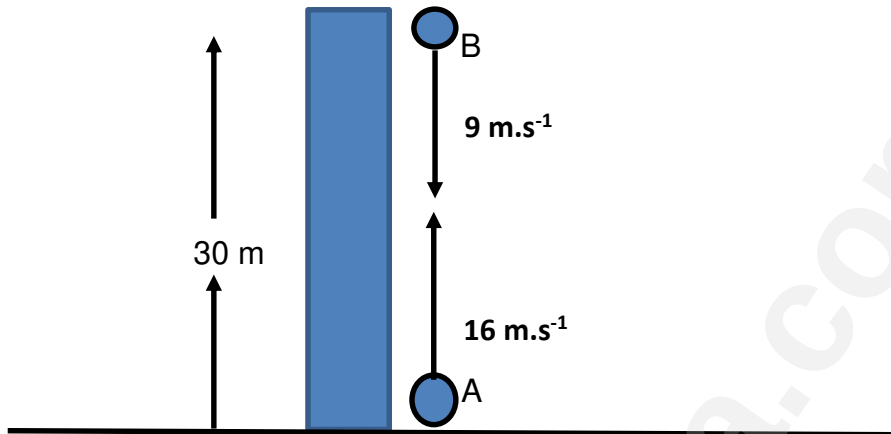
Ball A is projected vertically upwards at a velocity of $16 \text{ m}\cdot\text{s}^{-1}$ from the ground. Ignore the effects of air resistance. Use the ground as zero reference.

7.1 Calculate the time taken by ball A to return to the ground. **[3.27s]** (4)

7.2 Sketch a velocity-time graph for ball A. Show the following on the graph:

- Initial velocity of ball A
- Time taken to reach the highest point of the motion
- Time taken to return to the ground (3)

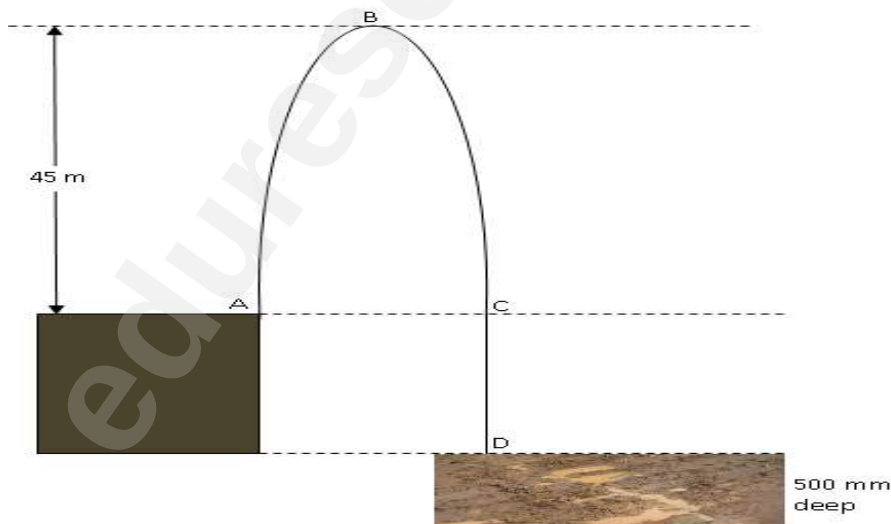
ONE SECOND after ball A is projected upwards, a second ball, B, is thrown vertically downwards at a velocity of $9 \text{ m}\cdot\text{s}^{-1}$ from a balcony 30 m above the ground. Refer to the diagram below.



7.3 Calculate how high above the ground ball A will be at the instant the two balls pass each other? [**11.25m**] (6)

QUESTION 8

A body of mass 2 kg, is projected vertically upwards from top of the building at an initial velocity of $x \text{ m}\cdot\text{s}^{-1}$, from point A and rises freely to point B, which is 45 m above point A, as shown on the given diagram below. B



8.1 Calculate the initial velocity, x of the body. [**29.7 $\text{m}\cdot\text{s}^{-1}$**]

8.2 Calculate the time taken to rise freely and reach point B. [**3,03 s**]

- 8.3 After the body has reached the maximum height, it falls freely .At point D it strikes the layer of mud, after it has passed point C.It took 2s to move from point C to reach point D and then it penetrates the mud to a depth of 500 mm before coming to rest.

8.3.1 Calculate the velocity with which the object strikes the ground. **[49,3m.s⁻¹]**

8.3.2 Calculate the magnitude of the average force exerted by the layer of mud to stop the body. **[4 880,58 N]**

8.3.3 How long it takes to stop the body after it has struck the layer of mud? . **[0,02 s]**

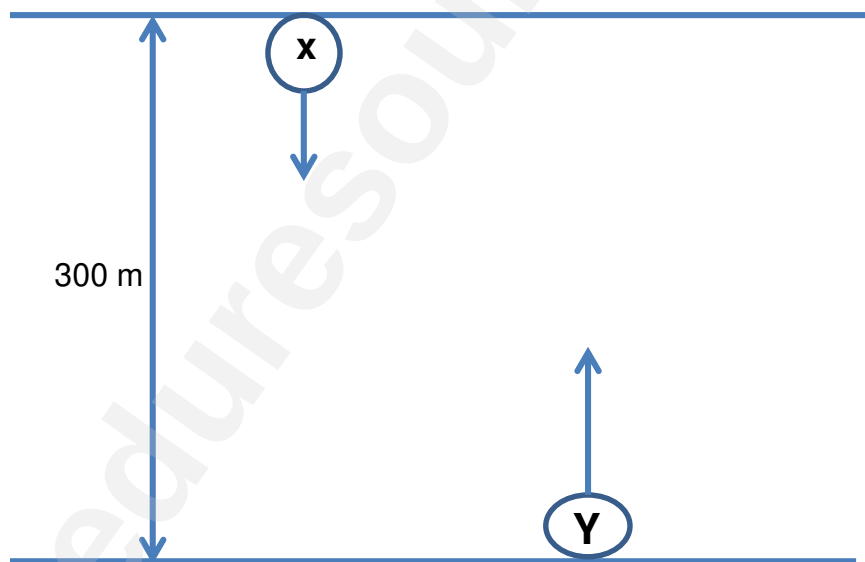
8.3.4 Calculate the impulse exerted by the layer of mud. . **[48,6 Ns]**

- 8.4 Draw the Velocity-Time graph for the motion of the object, from the moment it was projected upwards until it hits the ground at point D. Show all the velocity and time values on the graph.

- 8.5 Show on the graph, where the coordinates of point C can be read off.

QUESTION 9

An object X is dropped from a height of 300 m as in shown in the given diagram below. At exactly the same time another object Y is projected from the ground vertically upwards with an initial velocity of 150 m.s⁻¹.



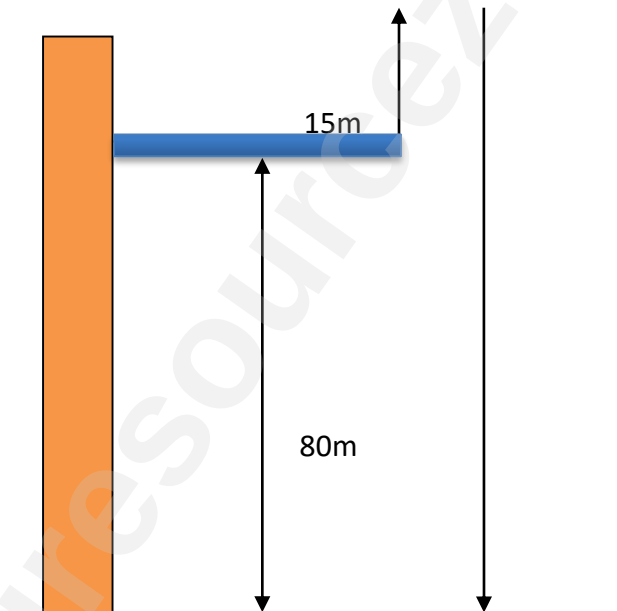
CALCULATE:

- 9.1 The velocity of object X when it hits the ground. . **[76.68 m.s⁻¹]**
- 9.2 The time for object X to hit the ground. . **[7.82 s]**
- 9.3 The time it takes for the two objects to reach the same height. . **[2 s]**
- 9.4 The height reached by the two objects above the ground when they pass each other. **[280,4 m]**

- 9.5 Maximum height reached by object Y. [**11,48 m**]
9.6 The time object Y takes to reach maximum height. . [**15,31 s**]
9.7 On the same set of axes draw the velocity – time graphs for object X from the moment it is dropped until it hits the ground AND object Y from the moment it was projected until it reaches maximum height.
9.8 On the same set of axes draw the position – time graphs for object X from the moment it is dropped until it hits the ground AND object Y from the moment it was projected until it reaches maximum height.

QUESTION 10

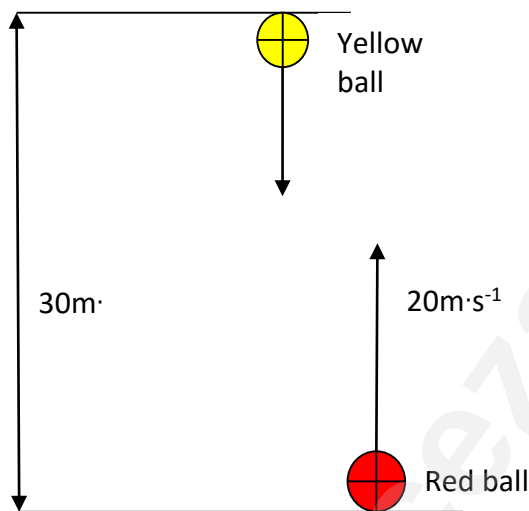
A cross- bow (bow and arrow) is used to shoot an arrow vertically upwards into the air from the top of an 80 m high platform. The arrow reaches height of 15 m above the platform and then falls to the ground below. Ignore the effects of air friction.



- 10.1 Calculate the magnitude of the velocity of the arrow at the instant it is shot up into the air from the top of the platform. . [**17.15 m.s⁻¹**]
10.2 Calculate the time it takes for the arrow to reach the ground from the moment it is shot upwards. [**6.15 s**]
10.3 Calculate the velocity with which the arrow strikes the ground. [**43.15 m.s⁻¹**]
10.4 Draw the velocity –time graph for the entire motion of the arrow

QUESTION 11

A red ball is thrown vertically upwards from the ground with an initial velocity of $20 \text{ m}\cdot\text{s}^{-1}$. At the same time an identical yellow ball is released from rest from a height of 30 m above the ground as shown on the diagram given below.



- 11.1 Calculate how long it will take the two balls to pass each other. **[1.5 s]**
- 11.2 At what height from the ground do they pass each other? **[18,98 m]**
- 11.3 Calculate the final velocity of the yellow ball as it hits the ground. **[24.25 $\text{m}\cdot\text{s}^{-1}$]**
- 11.4 How long it takes the yellow ball to hit the ground? **[2.5 s]**
- 11.5 What is the maximum height reached by the red ball? **[20.41 m]**
- 11.6 How long it takes the red ball to reach the maximum height? **[2.04 s]**
- 11.7 On the same set of axes draw position-time graphs for the motion of the two balls.
- 11.8 On the same set of axes draw velocity-time graphs for the motion of the two balls.



GAUTENG PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2016

GRADE 12

PHYSICAL SCIENCE

Session 2

MEMORUNDUM - VERTICAL PROJECTILES

MEMORANDUM FOR VERTICAL PROJECTILES - SESSION 2

- 1.1 B
- 1.2 C
- 1.3 A
- 1.4 D
- 1.5 B
- 1.6 A
- 1.7 D

QUESTION 1

- PENALISE ONLY ONCE FOR NOT ROUNDING OFF FINAL ANSWERS TO TWO DECIMAL PLACES.
- PENALISE ONE MARK (-1) FOR USING $g = 10 \text{ m}\cdot\text{s}^{-2}$ IN THIS QUESTION.
- Answers when using $g = 10 \text{ m}\cdot\text{s}^{-2}$ are given in brackets at all options.

1.1 3 seconds / 3 s ✓

[12.1.2] (1)

1.2

POSITIVE MARKING FROM QUESTION 1.1

Accept the equations:	
$v = u + at$	$s = ut + \frac{1}{2}at^2$
$s = \left(\frac{v+u}{2}\right)t$	$v^2 = u^2 + 2as$
Accept: symbols g for acceleration; $\Delta x / y / x$ for displacement; t for time	

144 m not accepted

OPTION 1

Area between graph and time axis

 $\Delta y = (\text{area of triangle}) / \frac{1}{2}bh \checkmark$

$$= \frac{1}{2}(3)(29,4) \checkmark$$

$$= 44,1 \text{ m}$$

Maximum height above ground:

$$100 + \checkmark 44,1 = 144,1 \text{ m} \checkmark$$

(if answer shows addition of 100 m ✓)

OPTION 2

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

$$= \left(\frac{0 + 29,4}{2}\right)3 \checkmark$$

$$= 44,1 \text{ m (43,22m)}$$

Maximum height above ground:

$$100 + \checkmark 44,1 = 144,1 \text{ m} \checkmark (143,22\text{m})$$

(if answer shows addition of 100 m ✓)

OPTION 3

From edge of cliff to max height

(Upward positive)

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

$$\therefore 0^2 = 29,4^2 + 2(-9,8)\Delta y \checkmark$$

$$\therefore \Delta y = 44,1 \text{ m (43,22m)}$$

Maximum height above ground:

$$100 + \checkmark 44,1 = 144,1 \text{ m} \checkmark (143,22\text{m})$$

(if answer shows addition of 100 m ✓)

From edge of cliff to max height)

(Downward positive)

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

$$\therefore 0^2 = (-29,4)^2 + 2(9,8)\Delta y \checkmark$$

$$\therefore \Delta y = -44,1 \text{ m (-43,22m)}$$

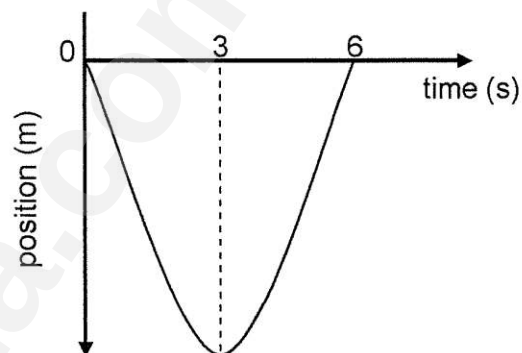
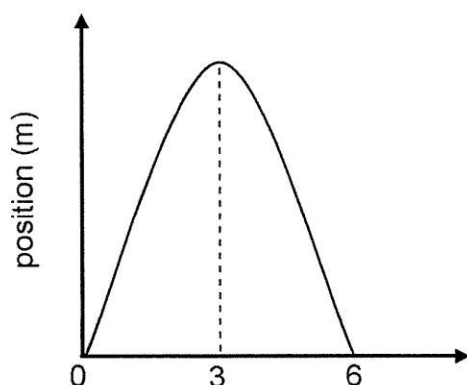
Maximum height above ground:

$$100 + \checkmark 44,1 = 144,1 \text{ m} \checkmark (143,22\text{m})$$

(if answer shows addition of 100 m ✓)

1.3 POSITIVE MARKING FROM QUESTION 1.1

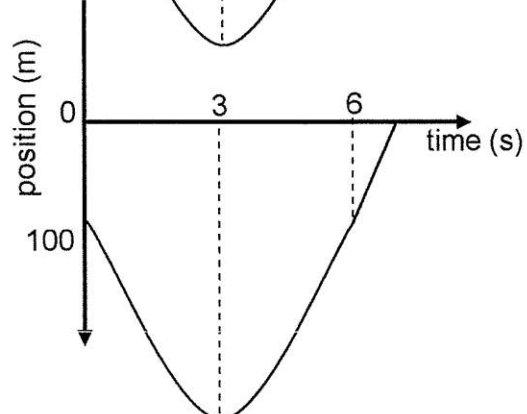
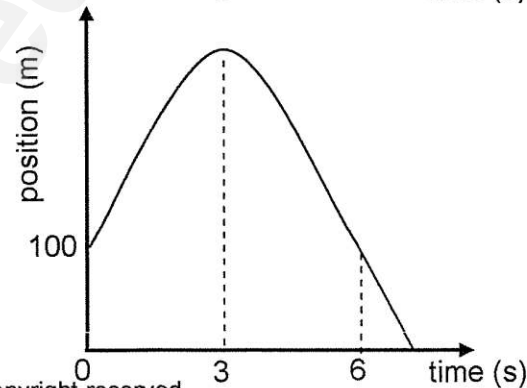
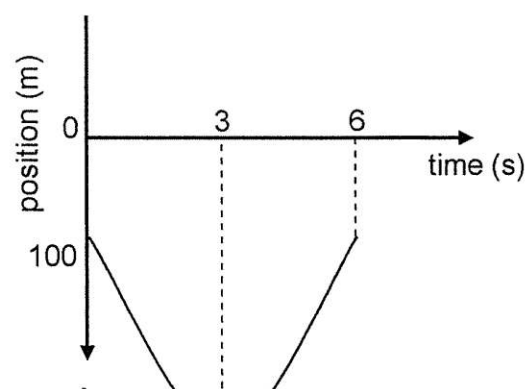
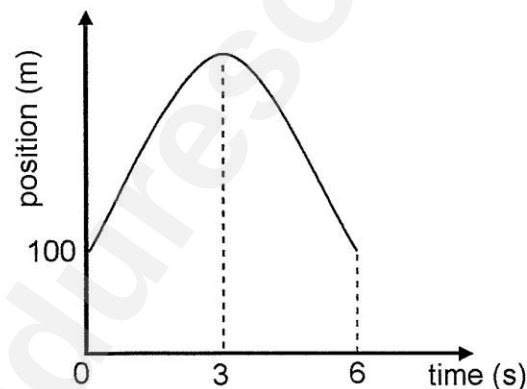
Checklist: Criteria for graph	Marks
Correct shape	✓
$t = 3 \text{ s}$ at maximum height	✓
$t = 6 \text{ s}$ at $y = 0 \text{ m}$	✓
Graph starts at $y = 0 \text{ m}$ at $t = 0 \text{ s}$	✓



Do not penalise if graph extends beyond 6 s.

IF GRAPH DOES NOT START AT $y = 0, t = 0$: Maximum 3 marks

Checklist: Criteria for graph	Marks
Correct shape	✓
$t = 3 \text{ s}$ at maximum height	✓
$t = 6 \text{ s}$ at $y = 100 \text{ m}$	✓



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1.4

OPTION 1: Upward positive: $v_f = v_i + a\Delta t$ ✓ $= 29,4 \checkmark + (-9,8)(5,23) \checkmark$ $= -21,85 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards } \checkmark (-22,9 \text{ m}\cdot\text{s}^{-1})$ OR $v_f = 21,85 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards} \checkmark$	Downward positive: $v_f = v_i + a\Delta t$ ✓ $= -29,4 \checkmark + (9,8)(5,23) \checkmark$ $= 21,85 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards } \checkmark (22,9 \text{ m}\cdot\text{s}^{-1})$
OPTION 2 $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= 29,4 (5,23) + \frac{1}{2} (-9,8)(5,23)^2$ $= 19,73 \text{ m} \quad (16,9975 \text{ m})$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both formulae) $= 29,4^2 \checkmark + 2(-9,8)(19,73) \checkmark$ $\therefore v_f = 21,85 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards } \checkmark (22,9 \text{ m}\cdot\text{s}^{-1})$	Downward positive: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ $= (-29,4)(5,23) + \frac{1}{2} (9,8)(5,23)^2$ $= -19,73 \text{ m} \quad (16,9975 \text{ m})$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both formulae) $= (-29,4)^2 \checkmark + 2(9,8)(-19,73) \checkmark$ $\therefore v_f = 21,85 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards } \checkmark (22,9 \text{ m}\cdot\text{s}^{-1})$
POSITIVE MARKING FROM 1.1 OPTION 3 (Downward motion only) Downward positive: Time for downward motion: $(5,23 - 3) \checkmark = 2,23 \text{ s}$ $v_f = v_i + a\Delta t$ ✓ $= 0 + (9,8)(2,23) \checkmark$ $= 21,85 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards } \checkmark (22,9 \text{ m}\cdot\text{s}^{-1})$	OPTION 4 Downward positive: Time for downward motion: $(5,23 - 3) \checkmark = 2,23 \text{ s}$ $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ (for both formulae) $= (0)(2,23) + \frac{1}{2} (9,8)(2,23)^2 \checkmark$ $= 24,36721 \text{ m} \quad (24,8654 \text{ m})$ $v_f^2 = v_i^2 + 2a\Delta y$ ✓ (for both formulae) $= (0)^2 + 2(9,8)(24,36721) \checkmark$ $\therefore v_f = 21,85 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards } \checkmark (22,3 \text{ m}\cdot\text{s}^{-1})$

[12.2.3] (5)

1.4 POSITIVE MARKING FROM QUESTION 1.3

OPTION 1

Upward positive:

$$\Delta t = (5,23 - 1) \checkmark = 4,23 \text{ s}$$

$$v_f = v_i + a\Delta t \checkmark$$

$$= 49 + (-9,8)(4,23) \checkmark$$

$$v_f = 7,55 \text{ m}\cdot\text{s}^{-1} \text{ upwards } (6,7 \text{ m}\cdot\text{s}^{-1})$$

$$\Delta v_{XY} = v_X - v_Y \text{ (vector difference)}$$

$$= -21,85 - 7,55$$

$$= -29,40 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards} \checkmark$$

OR

$$v_{XY} = 29,40 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards} \checkmark$$

$$v_{XY} = v_{XG} + v_{GY}$$

$$= -21,85 + (-7,55)$$

$$= -29,40 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards} \checkmark$$

OR

$$v_{XY} = 29,40 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards} \checkmark$$

$$v_{XG} = v_{XY} + v_{YG}$$

$$-21,85 = v_{XY} + (7,55)$$

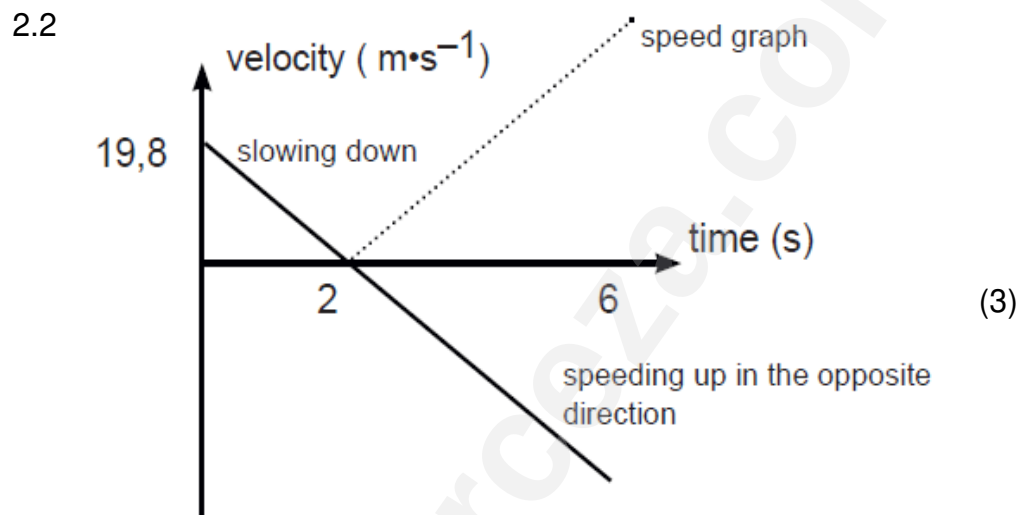
$$= -29,40 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards} \checkmark$$

OR

$$v_{XY} = 29,40 \text{ m}\cdot\text{s}^{-1} \checkmark \text{downwards} \checkmark$$

QUESTION2

2.1 $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
 $-57,6 = v_i 6 + \frac{1}{2} (-9,8) 6^2$
 $-57,6 = v_i 6 - 176,4$
 $176,4 - 57,6 = v_i 6$
 $v_i = \frac{118,8}{6} = 19,8 \text{ m}\cdot\text{s}^{-1} \text{ upwards}$ (4)



QUESTION 3/VRAAG 3

3.1

3.1.1

3.1.2

Upwards / Opwaarts ✓

Downwards / Afwaarts ✓

3.2

3.3

Q ✓

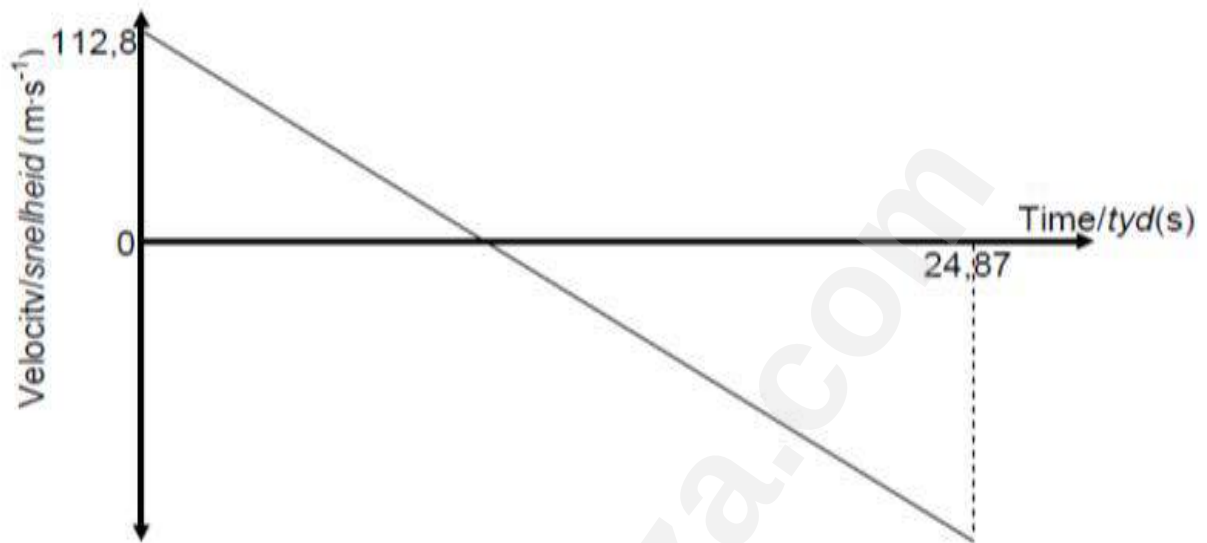
Weight is the only force acting on the rocket. ✓

Gewig is die enigste krag wat op die vuurpyl inwerk.

OPTION 1/OPSIE 1 Upwards positive/Opwaarts positief: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \quad \checkmark$ $\therefore -225,6 \checkmark = (112,8) \Delta t \checkmark + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$ $\therefore \Delta t = 24,87 \text{ s}$ ↓ Total time/Totale tyd: $4 + \checkmark 24,87 = 28,87 \text{ s} \checkmark$ Downwards positive/Afwaarts positief: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \quad \checkmark$ $\therefore 225,6 \checkmark = (-112,8) \Delta t \checkmark + \frac{1}{2} (9,8) \Delta t^2 \checkmark$ $\therefore \Delta t = 24,87 \text{ s}$ ↓ Total time/Totale tyd: $4 + \checkmark 24,87 = 28,87 \text{ s} \checkmark$	Notes/Aantekeninge: Accept/Aanvaar: g or/of a $s = ut + \frac{1}{2} at^2$ $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
OPTION 2/OPSIE 2 Upwards positive/Opwaarts positief: $v_f^2 = v_i^2 + 2a\Delta y$ $\therefore v_f^2 = (112,8)^2 + 2(-9,8)(-225,6) \checkmark$ $\therefore v_f = 130,94 \text{ m}\cdot\text{s}^{-1}$ ↘ $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \quad \checkmark$ $-225,6 \checkmark = \left(\frac{112,8 - 130,94}{2} \right) \Delta t \checkmark$ $\therefore \Delta t = 24,87 \text{ s}$ ↓ Total time/Totale tyd : $4 + \checkmark 24,87 = 28,87 \text{ s} \checkmark$ Downwards positive/Afwaarts positief: $v_f^2 = v_i^2 + 2a\Delta y$ $\therefore v_f^2 = (-112,8)^2 + 2(9,8)(225,6) \checkmark$ $\therefore v_f = 130,94 \text{ m}\cdot\text{s}^{-1}$ ↘ $\Delta y = \left(\frac{v_i + v_f}{2} \right) \Delta t \quad \checkmark$	Notes/Aantekeninge: Accept/Aanvaar: g or/of a $v_f^2 = v_i^2 + 2a\Delta x$ $v^2 = u^2 + 2as$ $\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t$ $s = \left(\frac{u + v}{2} \right) t$

OPTION 1/OPSIE 1

Upwards positive/Opwaarts positief:

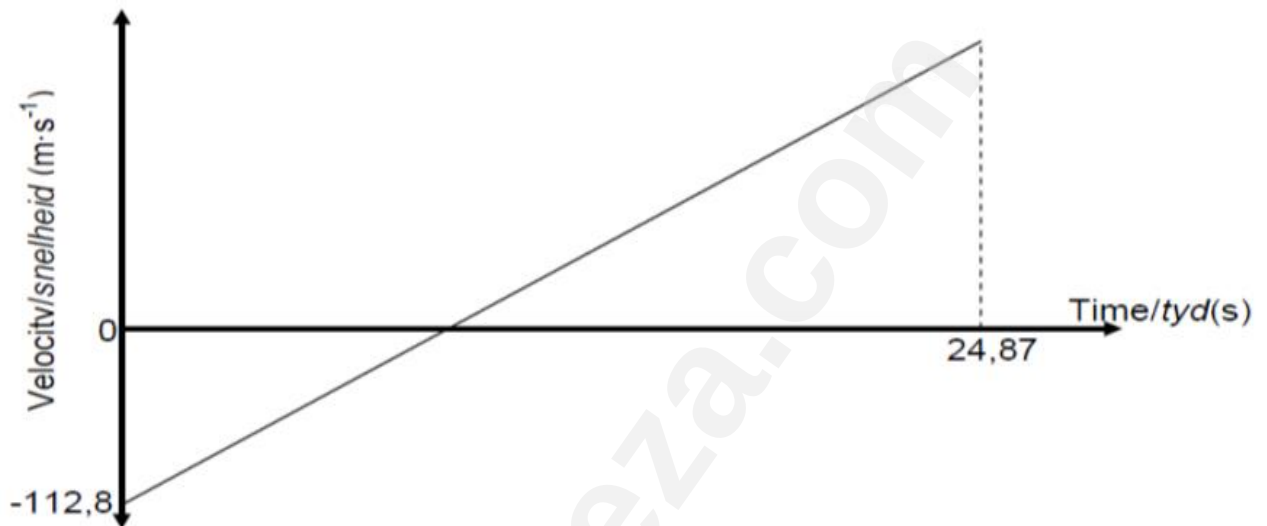


Criteria for graph/Kriteria vir grafiek:	Marks/ Punte
Graph starts at (0; 112,8). / Grafiek begin by (0; 112,8).	✓
Graph is a straight line with a gradient. / Grafiek is 'n reguitlyn met 'n gradiënt.	✓
Graph has a negative gradient. / Grafiek het 'n negatiewe gradiënt.	✓
POSITIVE MARKING FROM QUESTION 3.3./POSITIEWE NASIEN VANAF VRAAG 3.3.	
Graph extends below x-axis until t = 24,87 s. Grafiek verleng onder x-as tot t = 24,87s.	✓
Graph extends below the x-axis to a magnitude of the velocity greater than (112,8 m·s ⁻¹). / Tweede deel van grafiek verleng onder die x-as tot 'n grootte van die snelheid groter as (112,8 m·s ⁻¹).	✓

OPTION 2/OPSIE 2

If upwards taken as negative: Max $\frac{4}{5}$ /

Indien opwaarts as negatief geneem: Maks. $\frac{4}{5}$



Criteria for graph/Kriteria vir grafiek:	Marks/ Punte
Graph starts at (0; -112,8). / Grafiek begin by (0; -112,8).	✓
Graph is a straight line with a gradient. / Grafiek is 'n reguitlyn met 'n gradiënt.	✓
Graph has a positive gradient. / Grafiek het 'n positiewe gradiënt.	✓
POSITIVE MARKING FROM QUESTION 3.3./POSITIEWE NASIEN VANAF VRAAG 3.3. Graph extends above x-axis until t = 24,87 s. Grafiek verleng bo x-as tot t = 24,87s.	✓
Graph extends above the x-axis to a magnitude of the velocity greater than (112,8 m·s⁻¹). / Tweede deel van grafiek verleng bo die x-as tot 'n grootte van die snelheid groter as (112,8 m·s⁻¹).	✓

QUESTION 4

4.1 Free fall/Vrye val

ACCEPT/AANVAAR

Vertically accelerated motion/projectile motion.

*Vertikale versnelde beweging /projektielbeweging***Downward motion as positive**
Afwaartse beweging as positief

4.2.1 $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$
 $30 \checkmark = v_i (1,5) + \frac{1}{2} (9,8)(1,5)^2 \checkmark$
 $v_i = 12,65 \text{ m} \cdot \text{s}^{-1} \checkmark$

Upward motion as positive
Opwaartse beweging as positief

$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$
 $-30 \checkmark = v_i (1,5) + \frac{1}{2} (-9,8)(1,5)^2 \checkmark$
 $v_i = 12,65 \text{ m} \cdot \text{s}^{-1} \checkmark$

4.2.1

OPTION 1/OPSIE 1**Positive marking from QUESTION 4.2.1**
Positiewe nasien vanaf VRAAG 4.2.11**Downward motion as positive**
Afwaartse beweging as positief

$v_f^2 = v_i^2 + 2a\Delta y \checkmark$
 $12,65^2 \checkmark = 0 + 2(9,8) \Delta y \checkmark$
 $\Delta y = 8,16 \text{ m} \checkmark$
 Height/Hoogte **XC** = **XB** + **BC**
 $(30 + 8,16) = 38,16 \text{ m}$
 Height is/Hoogte is 38,16 m $\checkmark$

Notes / Aantekeninge

Accept/Aanvaar

g or/of a

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

$$s = ut + \frac{1}{2} at^2$$

Notes / AantekeningeFor/Vir **XB**

Accept/Aanvaar

g or/of a

$$v^2 = u^2 + 2as$$

The height must be written down in order to score the final mark.

Die hoogte moet neergeskryf word om die finale punt te kry.

4.2.2

Upward motion as positive
Opwaartse beweging as positief

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

$$(-12,65)^2 \checkmark = 0 + 2(-9,8) \Delta y \checkmark$$

$$\Delta y = -8,16 \text{ m} \checkmark$$

Height/Hoogte **XC = XB + BC**

$$(-30) + (-8,16) = -38,16 \text{ m}$$

Height is /Hoogte is 38,16 m) $\checkmark$

OPTION / OPSIE 2

Positive marking from QUESTION 4.2.1

Positiewe nasien vanaf VRAAG 4.2.1

Downward motion as positive

Afwaartse beweging as positief

$$v_B = v_X + a\Delta t \checkmark$$

$$12,65 = 0 + 9,8\Delta t \checkmark$$

$$\Delta t = 1,29 \text{ s}$$

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

$$= 0 + \frac{1}{2}(9,8)(1,29)^2 \checkmark$$

$$\Delta y = 8,15 \text{ m}$$

Height/Hoogte **XC = XB + BC**

$$(30 + 8,15) = 38,15 \text{ m} \checkmark$$

Upward motion as positive

Opwaartse beweging as positief

$$v_B = v_X + a\Delta t \checkmark$$

$$-12,65 = 0 + (-9,8)\Delta t \checkmark$$

$$\Delta t = 1,29 \text{ s}$$

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

$$= 0 + \frac{1}{2}(-9,8)(1,29)^2 \checkmark$$

$$\Delta y = -8,15 \text{ m}$$

Height/Hoogte **XC = XB + BC**

$$(-30) + (-8,15) = 38,15 \text{ m} \checkmark$$

Notes / Aantekeninge

Start with time for XB

Begin met tyd vir XB

Accept/Aanvaar

g or/of a

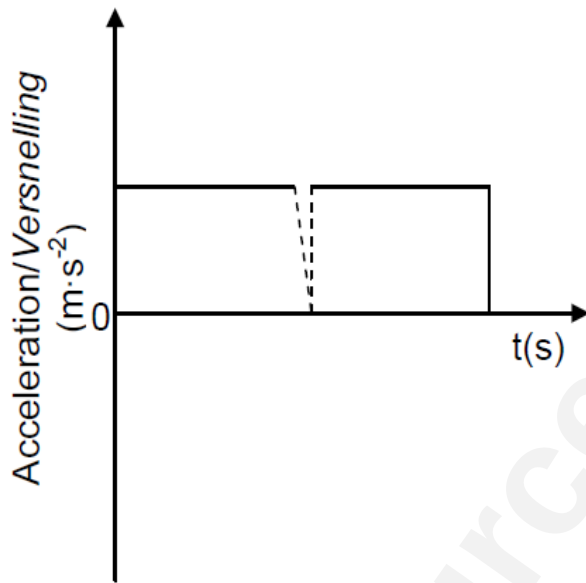
$$v = u + at$$

$$v^2 = u^2 + 2as$$

$$s = ut + \frac{1}{2}at^2$$

OPTION 3/OPSIE 3 Positive marking from QUESTION 4.2.1 Positiewe nasien vanaf VRAAG 4.2.1 Downward motion as positive Afwaartse beweging as positief $v_C = v_B + a\Delta t \checkmark$ $= 12,65 + 9,8 (1,5) \checkmark$ $= 27,35 \text{ m}\cdot\text{s}^{-1}$ $v_C^2 = v_X^2 + 2a\Delta y \checkmark$ $(27,35)^2 = 0 + 2(9,8) \Delta y \checkmark$ $\therefore \Delta y = 38,16 \text{ m}$ Height is /Hoogte is 38,16 m✓ Upward motion as positive Opwaartse beweging as positief $v_C = v_B + a\Delta t \checkmark$ $= -12,65 + (-9,8) (1,5) \checkmark$ $= -27,35 \text{ m}\cdot\text{s}^{-1}$ $v_C^2 = v_X^2 + 2a\Delta y \checkmark$ $(-27,35)^2 = 0 + 2(-9,8) \Delta y \checkmark$ $\therefore \Delta y = -38,16 \text{ m}$ Height/Hoogte = 38,16m✓	Notes / Aantekeninge start with velocity at C Accept/Aanvaar g or/of a $v = u + at$ $v^2 = u^2 + 2as$ The height must be written down in order to score the final mark. Die hoogte moet neergeskryf word om die finale punt te kry.
OPTION 4/OPSIE 4 Positive marking from QUESTION 4.2.1 Positiewe nasien vanaf VRAAG 4.2.1 $\Delta U + \Delta K = 0 \checkmark$ $(mgh + 0) \checkmark = 0 + (\frac{1}{2} m(12,65)^2) \checkmark$ $h = 8,16 \text{ m} \checkmark$ $XC = h + 30$ $= (30 + 8,16)$ $= 38,16 \text{ m} \checkmark$	Notes / Aantekeninge Accept/Aanvaar $mgh_i + \frac{1}{2} mv_i^2 = mgh_f + \frac{1}{2} mv_f^2$ Take point B as the zero position and $XH = h$ Neem punt B as nul posisie en $XH = h$

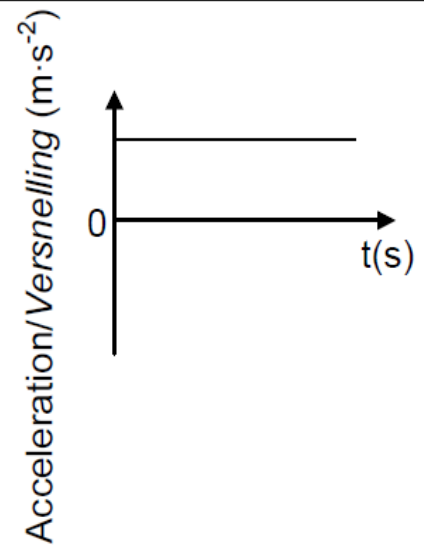
4.3

OPTION 1/OPSIE 1**Notes / Aantekeninge**

Criteria/Kriteria	Mark/Punt
For each line correctly drawn as shown <i>Vir elke lyn korrek geteken soos getoon</i>	✓✓
Both axes correctly labelled <i>Beide asse korrek benoem</i>	✓

Accept/Aanvaar

Only 2 marks for this answer/Slegs 2 punte vir hierdie antwoord



QUESTION 5

- 5.1 An object moving / Motion under the influence of gravity / weight / gravitational force only (and there are no other forces such as friction).✓✓ (2 or/of 0)
 ('n Voorwerp wat / Beweging slegs onder die invloed van swaartekrag / gewig / gravitasiekrag (en daar is geen ander kragte soos wrywing nie). (2)

OPTION 1/OPSIE 1 Upwards positive/Opwaarts positief: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $0 \checkmark = 15 \Delta t + \frac{1}{2} (-9,8) \Delta t^2$ ✓ $\Delta t = 3,06 \text{ s}$ It takes/Dit neem 3,06 s✓	Downwards positive/Afwaarts positief: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ ✓ $0 \checkmark = -15 \Delta t + \frac{1}{2} (9,8) \Delta t^2$ ✓ $\Delta t = 3,06 \text{ s}$ It takes/Dit neem 3,06 s✓
---	--

(4)

OPTION 2/OPSIE 2 Upwards positive/Opwaarts positief: $v_f = v_i + a \Delta t$ ✓ $0 \checkmark = 15 + (-9,8) \Delta t$ ✓ $\Delta t = 1,53 \text{ s}$ It takes (2)(1,53) = 3,06 s✓	Downwards positive/Afwaarts positief: $v_f = v_i + a \Delta t$ ✓ $0 \checkmark = -15 + (9,8) \Delta t$ ✓ $\Delta t = 1,53 \text{ s}$ It takes/Dit neem 3,06 s✓
---	---

(4)

OPTION 3 / OPSIE 3 Upwards positive/Opwaarts positief: $v_f = v_i + a \Delta t$ ✓ $-15 \checkmark = 15 + (-9,8) \Delta t$ ✓ $\Delta t = 3,06 \text{ s}$ ✓	Downwards positive/Afwaarts positief: $v_f = v_i + a \Delta t$ ✓ $15 \checkmark = -15 + (9,8) \Delta t$ ✓ $\Delta t = 3,06 \text{ s}$ ✓
---	---

(4)

5.3

OPTION 1/OPSIE 1**Upwards positive/Opwaarts positief:****Positive marking from QUESTION**

5.2

Positiewe nasien vanaf VRAAG

5.2

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

For ball A/Vir bal A

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

$$\Delta y_A = 11,479 \text{ m}$$

When A is at highest point

Wanneer A op hoogste punt is

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

$$= 0 \checkmark + \frac{1}{2}(-9,8)(1,531)^2 \checkmark$$

$$\Delta y_B = -11,485 \text{ m} \checkmark$$

$$\Delta y_B = 11,485 \text{ m downward/afwaarts}$$

$$\text{Distance/Afstand } y_A + y_B = (11,479 + 11,485) \checkmark$$

$$= 22,96 \text{ m} \checkmark$$

Downwards positive/Afwaarts positief:

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

For ball A/Vir bal A

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

$$\Delta y_A = -11,479 \text{ m} \checkmark$$

When A is at highest point

Wanneer A op hoogste punt is

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

$$= 0 \checkmark + \frac{1}{2}(9,8)(1,531)^2 \checkmark$$

$$\Delta y_B = 11,485 \text{ m}$$

$$\Delta y_B = 11,485 \text{ m downward/afwaarts}$$

$$\text{Distance/Afstand } (y_A + y_B) = (11,479 + 11,485) \checkmark$$

$$= 22,96 \text{ m} \checkmark$$

Notes/Aantekeninge

Accept/Aanvaar

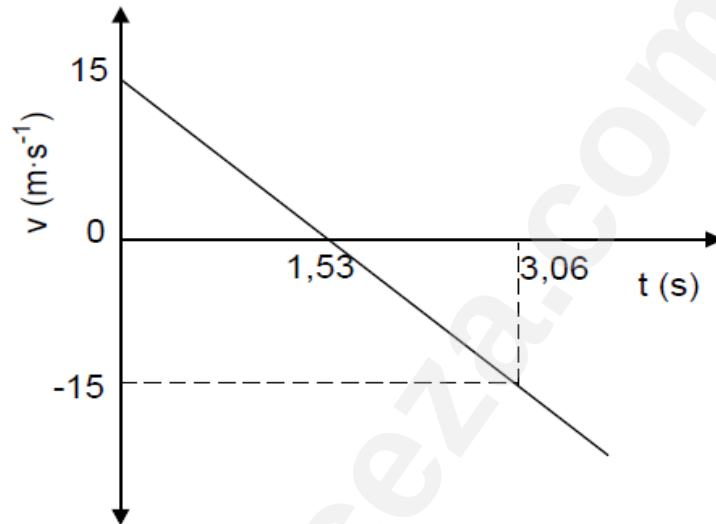
g or/of a

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

$$s = ut + \frac{1}{2}at^2$$

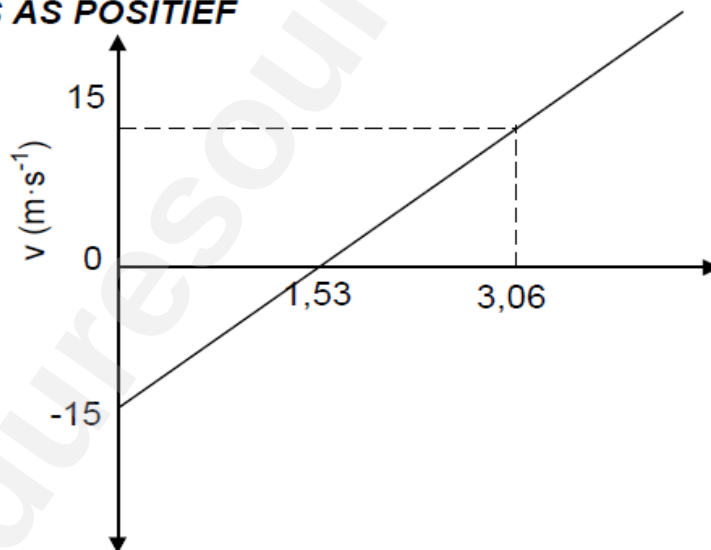
5.4 POSITIVE MARKING FROM QUESTION FROM 5.2

CONSIDER MOTION UPWARD AS POSITIVE/BESKOU BEWEGING OPWAARTS AS POSITIEF



(4)
[17]

CONSIDER MOTION DOWNWARD AS POSITIVE/BESKOU BEWEGING AFWAARTS AS POSITIEF



Criteria/Kriteria	Marks/Punte
Initial velocity shown./Beginsnelheid aangetoon.	✓
Time for maximum height shown./Tyd vir maksimum hoogte aangetoon.	✓
Time for return shown./Tyd om terug te keer aangetoon.	✓
Shape/Vorm: Straight line extending beyond 3,06 s / Reguitlyn wat verby 3,06 s strek.	✓

(4)
[17]

Question 6

6.1 When the camera falls from photographer's hand the :

6.1.1 Gravitational acceleration is $9,8 \text{ m}\cdot\text{s}^{-2}$ downwards. It is therefore a free-falling object.

While it is in photographer's hand, the camera has the same speed as photographer and the hot-air balloon, $5 \text{ m}\cdot\text{s}^{-1}$ upwards.

6.1.2 The moment photographer's lets it go, the initial velocity of the camera is also $5 \text{ m}\cdot\text{s}^{-1}$ upwards.

6.2 **Another method:**

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

$$v_f^2 = (+5)^2 + 2(-9,8)(-200)$$

$$v_f^2 = 3\,945$$

$$v_f = -62,81 \text{ m}\cdot\text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$-62,81 = 5 + (-9,8)\Delta t$$

$$\Delta t = 6,92 \text{ s}$$

The sign of v_f is negative because it works downwards.

OPTION 2

$$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \uparrow \text{UPWARDS+}$$

$$(200 \text{ down}) = (5 \text{ up})\Delta t + \frac{1}{2}(9,8 \text{ down})\Delta t^2$$

$$(-200) = (+5)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$$

$$4,9\Delta t^2 - 5\Delta t - 200 = 0$$

To solve the equation we use:

$$\Delta t = ? \quad \text{where } a = 4,9, b = -5 \text{ and } c = -200$$

$$\text{thus } \Delta t = \frac{-(-5) \pm \sqrt{(-5)^2 - 4(4,9)(-200)}}{2(4,9)} \quad \Delta t = 6,92 \text{ s}$$

$$\Delta t = 6,92 \text{ s}$$

6.3 In 3 s the balloon moves upwards with a **constant velocity** of $5 \text{ m}\cdot\text{s}^{-1}$, therefore the acceleration is $0 \text{ m}\cdot\text{s}^{-2}$.

$$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 \quad \uparrow +$$

$$= (+5)(3) + 0 = 15 \text{ m upwards above the initial position of the camera.}$$

The camera first moves upwards and then downwards with an acceleration of $9,8 \text{ m} \cdot \text{s}^{-2}$ downwards.

$$\begin{aligned}\Delta x &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \quad \uparrow + \\ &= +5(3) + \frac{1}{2}(-9,8)(3)^2 \\ &= -29,1 \text{ m}\end{aligned}$$

This means that the camera is now 29,1 m **below** its starting point.
The distance between the camera and photographer's hand is:
(15 + 29,1) = 44,1 m

QUESTION 7

7.1.

OPTION 1/OPSIE 1 Upwards positive/Opwaarts positief: $v_f = v_i + a\Delta t \checkmark$ $-16 \checkmark = 16 - 9,8(\Delta t) \checkmark$ $\Delta t = 3,27 \text{ s} \checkmark$	Downwards positive/Afwaarts positief: $v_f = v_i + a\Delta t \checkmark$ $16 \checkmark = -16 + 9,8(\Delta t) \checkmark$ $\Delta t = 3,27 \text{ s} \checkmark$	(4)
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OPTION 2/OPSIE 2 Upwards positive/Opwaarts positief: $v_f = v_i + a\Delta t \checkmark$ To the top/By bopunt: $0 \checkmark = 16 - 9,8(\Delta t) \checkmark$ $\Delta t = 1,63 \text{ s}$ Total time/Totale tyd = $1,63 \times 2$ $= 3,26(7) \text{ s} \checkmark$	Downwards positive/Afwaarts positief: $v_f = v_i + a\Delta t \checkmark$ To the top/By bopunt: $0 \checkmark = -16 + 9,8(\Delta t) \checkmark$ $\Delta t = 1,63 \text{ s}$ Total time/Totale tyd = $1,63 \times 2$ $= 3,26(7) \text{ s} \checkmark$	(4)
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NOTE/LET WEL:

v_i and v_f can be interchanged / v_i en v_f kan omgeruil word.

7.1

OPTION 3/OPSIE 3 Upwards positive/Opwaarts positief: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $0 \checkmark = 16 \Delta t + \frac{1}{2} (-9,8) \Delta t^2 \checkmark$ $\Delta t(16 - 4,9 \Delta t) = 0$ $\Delta t = 0$ or/of 3,27 s Time taken/Tyd geneem = 3,27 s (accept/aanvaar 3,26 s) $\checkmark$	Downwards positive/Afwaarts positief: $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $0 \checkmark = -16 \Delta t + \frac{1}{2} (9,8) \Delta t^2 \checkmark$ $\Delta t(-16 + 4,9 \Delta t) = 0$ $\Delta t = 0$ or/of 3,27 s Time taken/Tyd geneem = 3,27 s (accept/aanvaar 3,26 s) $\checkmark$	(4)
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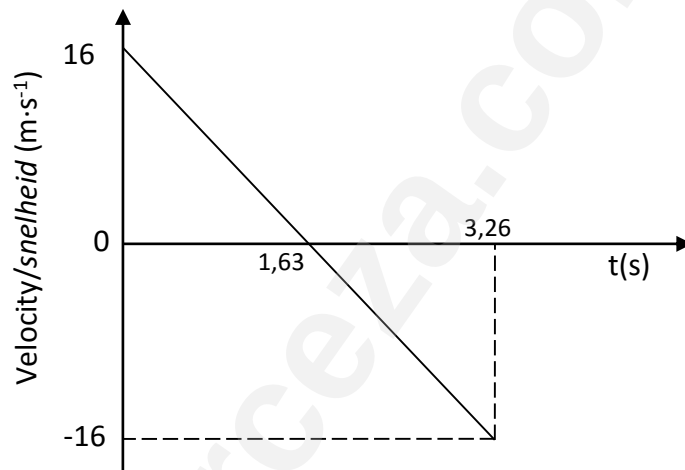
OPTION 4/OPSIE 4 Upwards positive/Opwaarts positief: $v_f^2 = v_i^2 + 2a\Delta y$ At highest point/By hoogste punt	Downwards positive/Afwaarts positief: $v_f^2 = v_i^2 + 2a\Delta y$ At highest point/By hoogste punt	(4)
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$0 = 16^2 + 2(-9,8)\Delta y \checkmark$ $\Delta y = 13,06 \text{ m}$ $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $13,06 = 16 \Delta t - 4,9 \Delta t^2 \checkmark$ $\Delta t = 1,62 \text{ or } 1,65$ Total time/ <i>Totale tyd</i> = $(1,62/1,65) \times 2$ = 3,24 s ✓ or/of 3,3 s	$0 = (-16)^2 + 2(9,8)\Delta y \checkmark$ $\Delta y = 13,06 \text{ m}$ $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$ $13,06 = -16 \Delta t + 4,9 \Delta t^2 \checkmark$ $\Delta t = 1,62 \text{ or } 1,65$ Total time/ <i>Totale tyd</i> = $(1,62/1,65) \times 2$ = 3,24 s ✓ or/of 3,3 s
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7.2

POSITIVE MARKING FROM 7.1./POSITIEWE NASIEN VANAF 7.1

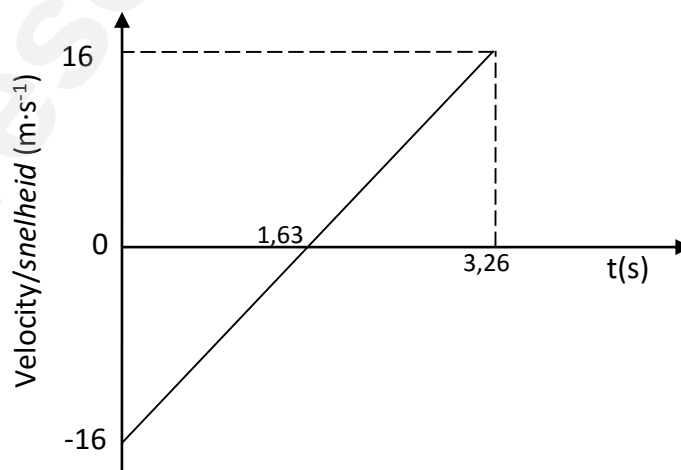
Upwards positive/Opwaarts positief:



(3)

POSITIVE MARKING FROM 7.2./POSITIEWE NASIEN VANAF 7.2

Downwards positive/Afwaarts positief:



Criteria for graph/Kriteria vir grafiek	Marks/Punte
Correct shape for line extending beyond $t = 1,63$ s. <i>Korrekte vorm vir lyn verleng verby $t = 1,63$ s</i>	✓
Initial velocity correctly indicated as shown. <i>Beginsnelheid korrek aangedui soos getoon.</i>	✓
Time to reach maximum height and time to return to the ground correctly shown. <i>Tyd om maksimum hoogte te bereik en om na die grond terug te keer.</i>	✓ (3)
NOTE/LET WEL: Do not penalise if the velocity to return is not indicated or labels not indicated. <i>Moenie penaliseer indien terugkeer snelheid nie aangedui is nie.</i>	

7.3

OPTION 1 / OPSIE 1**Upwards positive/Opwaarts positief:**

Take y_A as height of ball A from the ground. (no penalising)/Neem y_A as hoogte van bal A vanaf die grond. (geen penalisering)

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

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

$$= 16\Delta t - 4,9\Delta t^2 \checkmark$$

Take y_B as height of ball B from the ground./Neem y_B as hoogte van bal B vanaf die grond.

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

$$y_B - 30 = (v_i \Delta t + \frac{1}{2} a \Delta t^2)$$

$$y_B = 30 - [-9(\Delta t - 1) + \frac{1}{2}(-9,8)(\Delta t - 1)^2] \checkmark$$

$$= 34,1 + 0,8\Delta t - 4,9\Delta t^2 \checkmark$$

$$y_A = y_B$$

$$\therefore 16\Delta t - 4,9\Delta t^2 = 34,1 + 0,8\Delta t - 4,9\Delta t^2$$

$$15,2\Delta t = 34,1$$

$$\Delta t = 2,24 \text{ s } \checkmark$$

$$y_A = 16(2,24) - 4,9(2,24)^2$$

$$= 11,25 \text{ m } \checkmark$$

✓ Both/Beide een

(6)

Downwards positive/Afwaarts positief:

Take y_A as height of ball A from the ground. (no penalising)/Neem y_A as hoogte van bal A vanaf die grond. (geen penalisering)

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

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

$$= -16\Delta t + 4,9\Delta t^2 \checkmark$$

Take y_B as height of ball B from the ground/Neem as hoogte van bal B vanaf die grond..

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

$$y_B - 30 = -(v_i \Delta t + \frac{1}{2} a \Delta t^2)$$

$$y_B = 30 - [9(\Delta t - 1) + \frac{1}{2}(9,8)(\Delta t - 1)^2] \checkmark$$

$$= 34,1 + 0,8\Delta t - 4,9\Delta t^2 \checkmark$$

$$y_A = y_B$$

$$16\Delta t - 4,9\Delta t^2 = 34,1 + 0,8\Delta t - 4,9\Delta t^2$$

$$15,2\Delta t = 34,1$$

$$\Delta t = 2,24 \text{ s} \checkmark$$

$$\Delta y_A = (-16(2,24) + 4,9(2,24)^2)$$

$$= 11,25 \text{ m} \checkmark$$

✓ Both/Beide een

(6)

7.3

OPTION 2/OPSIE 2**Upwards positive/Opwaarts positief:**

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

$$= 16\Delta t + \frac{1}{2}(-9,8)\Delta t^2$$

$$= 16\Delta t - 4,9\Delta t^2 \checkmark$$

$$\text{Distance travelled by ball A} = y_A = 16\Delta t - 4,9\Delta t^2$$

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

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

$$= 0,8\Delta t - 4,9\Delta t^2 + 4,1 \checkmark$$

$$\text{Distance travelled by ball B} = y_B = 0,8\Delta t - 4,9\Delta t^2 + 4,1$$

$$y_A + (-y_B) = 30$$

$$16\Delta t - 4,9\Delta t^2 - (0,8\Delta t - 4,9\Delta t^2 + 4,1) = 30$$

$$15,2\Delta t = 34,1$$

$$\Delta t = 2,24 \text{ s} \checkmark$$

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

$$y_A = 16(2,24) - 4,9(2,24)^2$$

$$= 11,25 \text{ m} \checkmark$$

✓ Both/Beide een

(6)

7.3

Downwards positive/Afwaarts positief:

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

$$= -16\Delta t + \frac{1}{2}(9,8)\Delta t^2$$

$$= -16\Delta t + 4,9\Delta t^2 \checkmark$$

$$\text{Distance travelled by ball A} = y_A = -16\Delta t + 4,9\Delta t^2$$

✓ Both/Beide een

(6)

$$\begin{aligned}\Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= 9(\Delta t - 1) + \frac{1}{2}(9,8)(\Delta t - 1)^2 \checkmark \\ &= -0,8\Delta t + 4,9\Delta t^2 - 4,1 \checkmark\end{aligned}$$

$$\text{Distance travelled by ball B} = y_B = 0,8\Delta t + 4,9\Delta t^2 - 4,1$$

$$\begin{aligned}(-y_A) + y_B &= 30 \\ -(-16\Delta t + 4,9\Delta t^2) - 0,8\Delta t + 4,9\Delta t^2 - 4,1 &= 30 \\ 15,2\Delta t &= 34,1 \\ \Delta t &= 2,24 \text{ s} \checkmark\end{aligned}$$

$$\begin{aligned}\therefore \Delta y_A &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ \Delta y_A &= -16(2,24) + 4,9(2,24)^2 \\ &= -11,25 \text{ m} \\ \therefore \text{Height of ball A/Hoogte van bal A} &= 11,25 \text{ m} \checkmark\end{aligned}$$

OPTION 3/OPSIE 3**Upwards positive/Opwaarts positief:**

$$\begin{aligned}v_f &= v_i + a\Delta t \\ \text{After 1 s, speed of ball A/Spoed van bal A na 1 s} \\ v_f &= 16 + (-9,8)(1) \\ &= 6,2 \text{ m}\cdot\text{s}^{-1}\end{aligned}$$

Distance travelled by ball A in 1 s/Afstand deur bal A afgelê in 1 s

$$\begin{aligned}\Delta y_A &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= (16)(1) + \frac{1}{2}(-9,8)1^2 \\ &= 11,1 \text{ m}\end{aligned}$$

For ball A, after 1 s/Vir bal A na 1 s

$$\Delta y_A = 6,2\Delta t - 4,9\Delta t^2 \checkmark$$

For ball/Vir bal B,

$$\begin{aligned}\Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= -9\Delta t + \frac{1}{2}(-9,8)\Delta t^2 \checkmark\end{aligned}$$

$$\begin{aligned}y_A + (-y_B) &= (30 - 11,1) = 18,9 \\ 6,2\Delta t - 4,9\Delta t^2 - [-9\Delta t + \frac{1}{2}(-9,8)\Delta t^2] &= 18,9 \\ 15,2\Delta t &= 18,9 \\ \Delta t &= 1,24 \text{ s} \checkmark\end{aligned}$$

The balls meet after/Die balle ontmoet na $(1,24 + 1) = 2,24 \text{ s} \checkmark$

$$\begin{aligned}\Delta y_A &= [6,2(1,24) - 4,9(1,24)^2] \\ &= 0,154 \text{ m}\end{aligned}$$

Meeting point/Ontmoetingspunt $= (11,1 + 0,154) = 11,25 \text{ m} \checkmark$ **OR/OF**

$$\begin{aligned}\Delta y &= (-9)(1,24) + \frac{1}{2}(-9,8)(1,24)^2 \checkmark \\ &= -18,69 \text{ m}\end{aligned}$$

✓ Both/Beide een

Meeting point/Ontmoetingspunt = $(30 - 18,69) = 11,31 \text{ m}$ ✓
--

Downwards positive/Afwaarts positief:

$$v_f = v_i + a\Delta t$$

After 1 s, speed of ball A/Spoed van bal A na 1 s

$$\begin{aligned} v_f &= -16 + (9,8)(1) \\ &= -6,2 \text{ ms}^{-1} \end{aligned}$$

Distance travelled by ball A in 1 s/Afstand deur bal A afgelê in 1 s

$$\begin{aligned} \Delta y_A &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= (-16)(1) + \frac{1}{2}(9,8)(1)^2 \\ &= -11,1 \text{ m} \end{aligned}$$

For ball A, after 1 s/Vir bal A na 1 s

$$\Delta y_A = -6,2\Delta t + 4,9\Delta t^2 \checkmark$$

✓ Both/Beide een

For ball/Vir bal B

$$\begin{aligned} \Delta y_B &= v_i \Delta t + \frac{1}{2} a \Delta t^2 \\ &= 9\Delta t + \frac{1}{2}(9,8)\Delta t^2 \checkmark \end{aligned}$$

$$-\Delta y_A + \Delta y_B = 18,9$$

$$6,2\Delta t - 4,9\Delta t^2 + [9\Delta t + \frac{1}{2}(9,8)\Delta t^2] = 18,9$$

$$15,2\Delta t = 18,9$$

$$\Delta t = 1,24 \text{ s} \checkmark$$

The balls meet after/Die balle ontmoet na $(1,24 + 1) = 2,24 \text{ s}$ ✓

$$\begin{aligned} \Delta y_A &= -6,2(1,24) + 4,9(1,24)^2 \\ &= -0,154 \text{ m} \end{aligned}$$

$$\text{Meeting point/Ontmoetingspunt} = (-11,1 - 0,154) = 11,25 \text{ m} \checkmark$$

OR/OF

$$\begin{aligned} \Delta y &= (9)(1,24) + \frac{1}{2}(9,8)(1,24)^2 \checkmark \\ &= 18,69 \text{ m} \end{aligned}$$

$$\text{Meeting point/Ontmoetingspunt} = (30 - 18,69) = 11,31 \text{ m} \checkmark$$

(6)
[13]

QUESTION 8

Take upwards as negative

$$8.1 \quad v_f^2 = v_i^2 + 2a\Delta y$$

$$(0)^2 = v^2 + 2(9.8)(-45)$$

$$\mathbf{v = 29.7 \text{ m}\cdot\text{s}^{-1} \text{ upwards}}$$

$$8.2 \quad v_f = v_i + a\Delta t$$

$$0 = -29.7 + (9.8)\Delta t$$

$$\Delta t = \mathbf{3.03 \text{ s}}$$

$$8.3.1 \quad v_f = v_i + a\Delta t$$

$$= 0 + 9.8(5.03)$$

$$\mathbf{v_f = 49.3 \text{ m}\cdot\text{s}^{-1}}$$

8.3.2 Acceleration in the mud:

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

$$(0)^2 = (49.3)^2 + 2a(0.5)$$

$$\mathbf{a = -2430.49 \text{ m}\cdot\text{s}^{-2}}$$

Therefore: $F_{\text{net}} = ma$

$$ma = F_g + F_{\text{mud}}$$

$$2(2430.49) = 2(-9.8) + F_{\text{mud}}$$

$$\mathbf{F_{\text{mud}} = 4\,880.58 \text{ N upwards}}$$

$$8.3.4 \quad \Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$$

$$(0.5) = \left(\frac{0 + 49.3}{2}\right)\Delta t$$

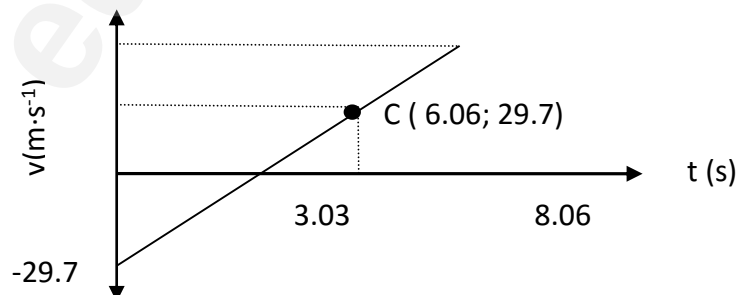
$$\Delta t = \mathbf{0.0203 \text{ s}}$$

$$8.4 \quad \text{Impulse} = m(v_f - v_i)$$

$$= 2(0 - 49.3)$$

$$= \mathbf{98.6 \text{ N}\cdot\text{s}}$$

8.5



8.6 Refer to point C on the graph.

QUESTION 9

$$\begin{aligned}
 9.1 \quad v_f^2 &= v_i^2 + 2a\Delta y \\
 &= (0)^2 + 2(9.8)(300) \\
 \mathbf{v_f} &= \mathbf{76.68 \text{ m}\cdot\text{s}^{-1}}
 \end{aligned}$$

$$\begin{aligned}
 9.2 \quad v_f &= v_i + a\Delta t \\
 76.68 &= 0 + 9.8 \Delta t \\
 \mathbf{\Delta t} &= \mathbf{7.8 \text{ s}}
 \end{aligned}$$

$$\begin{aligned}
 9.3 \quad \Delta y &= V_i\Delta t + \frac{1}{2}g\Delta t^2 \quad (\text{let the height be } x) \\
 -x &= -150t + \frac{1}{2}(9.8)\Delta t^2 \\
 \mathbf{x} &= \mathbf{150t - 4.9t^2 \dots\dots \text{Eq (1)}}
 \end{aligned}$$

$$\begin{aligned}
 \Delta y &= V_i\Delta t + \frac{1}{2}g\Delta t^2 \\
 300 - x &= 0 + \frac{1}{2}(9.8)\Delta t^2 \\
 \mathbf{x} &= \mathbf{300 - 4.9t^2 \dots\dots \text{Eq (2)}}
 \end{aligned}$$

$$\text{Eq (1)} = \text{Eq(2)} \rightarrow 150t - 4.9t^2 = 300 - 4.9t^2$$

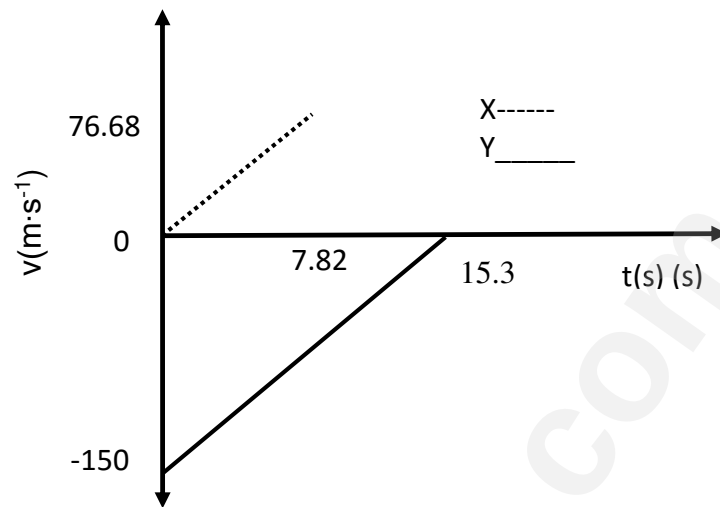
t = 2 s: is time taken to reach same height.

9.4 Substitute t = 2 s into (1) or (2)
 $x = 300 - 4.9(2)^2$
 $\therefore \mathbf{x = 280.4 \text{ m}}$ **is the height reached by the 2 objects simultaneously.**

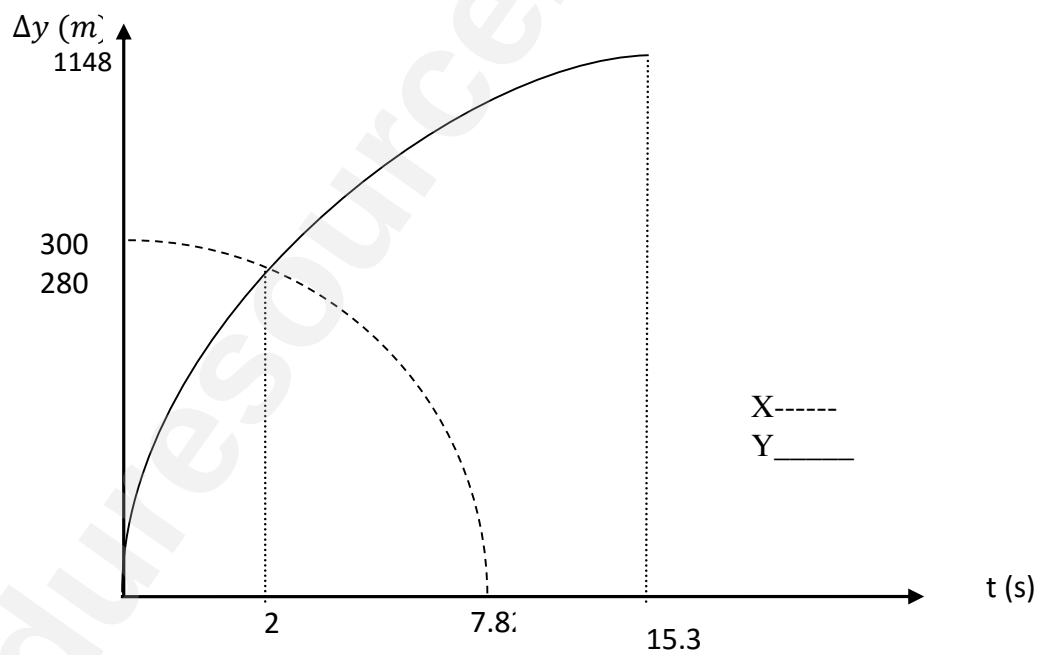
$$\begin{aligned}
 9.5 \quad v_f^2 &= v_i^2 + 2a\Delta y \\
 (0)^2 &= (150)^2 + 2(9.8)\Delta y \\
 \Delta y &= 1147.959 \\
 \mathbf{\Delta y \text{ 1148 m}} &\mathbf{\text{ is the maximum height reached by object Y.}}
 \end{aligned}$$

$$\begin{aligned}
 9.6 \quad v_f &= v_i + a\Delta t \\
 0 &= -150 + 9.8 \Delta t \\
 \mathbf{\Delta t} &= \mathbf{15.31 \text{ s}}
 \end{aligned}$$

9.7 Velocity – time graph



9.8 Position vs time graph



QUESTION 10

$$10.1 \quad v_f^2 = v_i^2 + 2a\Delta y$$

$$(0)^2 = (v_i)^2 + 2(9.8)(-15)$$

$$v_i = 17.15 \text{ m} \cdot \text{s}^{-1} \quad \text{upwards}$$

$$V_F = V_I + g\Delta t$$

$$0 = -17.15 + 9.8 \Delta t$$

$$\Delta t = 1.75 \text{ s time taken to reach maximum height}$$

$$10.2 \quad v_f^2 = v_i^2 + 2a\Delta y$$

$$(V_F)^2 = (0)^2 + 2(9.8)(95)$$

$$V_F = 43.15 \text{ m} \cdot \text{s}^{-1}$$

$$v_f = v_i + a\Delta t$$

$$43.15 = 0 + 9.8 \Delta t$$

$$\Delta t = 4.4 \text{ s is time taken to move from maximum height to the ground .}$$

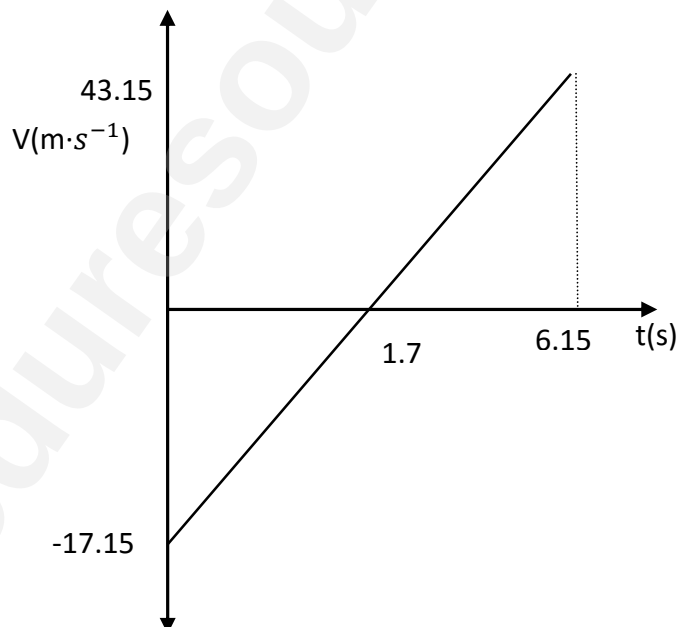
The total time taken to reach the ground = 4.4 + 1.7 = 6.15 s

$$10.3 \quad v_f^2 = v_i^2 + 2a\Delta y$$

$$(V_F)^2 = (0)^2 + 2(9.8)(95)$$

$$V_F = 43.15 \text{ m} \cdot \text{s}^{-1}$$

10.4 Velocity – time graph



QUESTION 11

11.1 Red ball: $\Delta y = V_i \Delta t + \frac{1}{2} g t^2$

$$-y = -20 t + \frac{1}{2} (9.8) t^2$$

$$y = 20t - 4.9t^2 \dots \text{Eq (1)}$$

Yellow ball: $\Delta y = V_i \Delta t + \frac{1}{2} g \Delta t^2$

$$30 - y = 0 + \frac{1}{2} (9.8) t^2$$

$$y = 30 - 4.9t^2 \dots \text{Eq (2)}$$

$$\text{Eq (1)} = \text{Eq (2)} \rightarrow 20t - 4.9t^2 = 30 - 4.9t^2$$

$$t = 1.5 \text{ s}$$

11.2 Substitute $t = 1.5 \text{ s}$ into (1) or (2)

$$y = 30 - 4.9(1.5)^2$$

$$y = 18.98 \text{ m}$$

11.3 $v_f^2 = v_i^2 + 2a\Delta y$

$$= (0)^2 + 2(9.8)(30)$$

$$V_f = 24.25 \text{ m} \cdot \text{s}^{-1}$$

11.4 $V_F = V_i + g\Delta t$

$$24.25 = 0 + 9.8 t$$

$$t = 2.5 \text{ s}$$

11.5 Red ball: $v_f^2 = v_i^2 + 2a\Delta y$

$$(0)^2 = (-20)^2 + 2(9.8) \Delta y$$

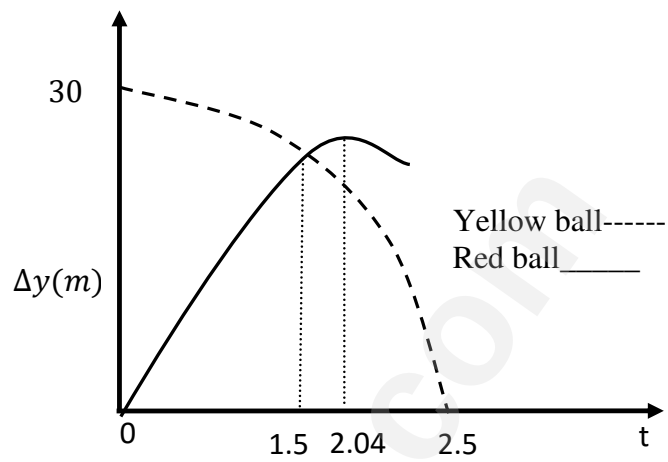
$$\Delta y = 20.41 \text{ m}$$

11.6 $V_F = V_i + g\Delta t$

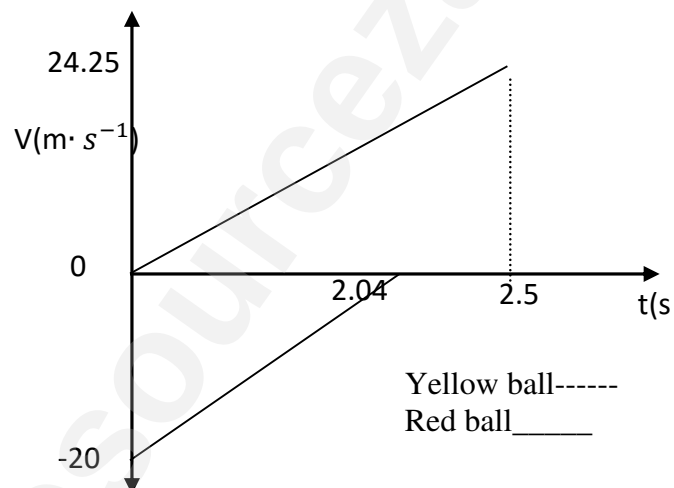
$$0 = -20 + 9.8t$$

$$t = 2.04 \text{ s}$$

11.7 Position vs time graph



11.8 Velocity – time graphs



SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2016



GAUTENG PROVINCE

EDUCATION

REPUBLIC OF SOUTH AFRICA

GRADE 12

SUBJECT: PHYSICAL SCIENCE

TERM 01

ORGANIC CHEMISTRY

SESSION 3

ORGANIC MOLECULES

1. ALL DEFINITIONS IN THIS TOPIC NEEDS TO BE GIVEN TO LEARNERS AT THE BEGINNING OF THE TOPIC AND SHOULD BE LEARNED
 - HOMOLOGOUS SERIES
 - FUNCTIONAL GROUP
 - ISOMERS: STRUCTURAL ISOMER, CHAIN ISOMERS, POSITIONAL ISOMERS
2. ISOMERISM NEEDS TO BE TAUGHT IN DETAIL AND APPLIED TO ALL THE VARIOUS HOMOLOGOUS SERIES
3. ALL FORMULAE NEED TO BE TAUGHT:
 - MOLECULAR
 - STRUCTURAL
 - CONDENSED STRUCTURAL
 - CONDENSED STRUCTURES
4. REPRESENTATION OF ORGANIC MOLECULES IN ALL FORMS
 - STRUCTURAL
 - CONDENSED STRUCTURAL FORMULA
5. USE EASY WAYS TO HELP LEARNERS DRAW STRUCTURAL FORMULAE **E.G. CARBOXYLIC ACIDS AND ALDEHYDES** ARE EASY TO DRAW IF YOU START WITH A FUNCTIONAL GROUP AND MOVE BACKWARD
6. AT THE END OF THE ORGANIC COMPOUNDS TOPIC, THE FOLLOWING ARE EXAMINABLE:
 - NAMING AND IDENTIFYING ORGANIC MOLECULES
 - PROPERTIES OF ORGANIC MOLECULES **-ONLY BOILING POINT, MELTING POINT AND VAPOUR PRESSURE ARE EXAMINABLE**
 - ORGANIC REACTIONS
7. NAMING OF ORGANIC MOLECULES-ALL RULES NEED TO BE TAUGHT AT THE BEGINNING OF THE TOPIC SO THAT LEARNERS ARE ABLE TO APPLY THEM IN NAMING ORGANIC MOLECULES

RULES OF NAMING ORGANIC MOLECULES:

1. **Identify the longest carbon chain.** This will serve as the structure for the compound. Choose the chain in such a way that all functional groups are part of the main structure or chain. Number the chain in such a way that functional groups are attached to the carbon with the lowest possible number. In the absence of a definitive functional group side chains will have to have the lowest number.
2. **Begin the IUPAC name by starting at the back.** Write down the suffix of the series to which the main chain belongs. This will be decided by the functional group contained in the main chain. If there is a double bond the suffix would be –ene. Specify in front of the completed word on which carbon a double- or triple bond starts.
3. In cases where there is more than one double- or triple bond **the appropriate prefix should be used:** e.g. –diene; -triene; -diyne; -triyne. In front of the completed word specify on which carbon atoms the double or triple bonds begin. If there are three double bonds you should have three specifying numbers, one for each starting point of each bond.
4. **Count the amount of carbons in the main chain** and use this to determine the prefix of the name. For one to ten carbons use the appropriate prefix from the following list: meth-; eth-; prop-; but-; pent-; hex-; hept-; oct-; non-; dec-.
5. **Side chains are called alkyl groups.** Name the side chains by counting only the carbons in the specific side chain and use this to determine the prefix for the side chain. In front of each name of a side chain write the number of the carbon in the main chain to which it is bonded.
6. When there is **more than one of the same side chains** group them together by using prefixes di- tri- and tetra-. In front of the side chain's name use the carbon numbers to which each chain is bonded.
7. **When halogen atoms are present** in the molecule name them by using the terms chloro- bromo- .when there are more than one of the same atom use the prefixes di-; tri- or tetra-again specify onto which carbon in the main chain it is bonded by adding the number of main chain carbon in front of the name.
8. **When there are –OH groups use the suffix –ol.** Again specify on which carbon the –OH is bonded in the middle of the name by writing down the number of that carbon. When there are more than one –OH group use –diol; -triol; etc.
9. **Carboxylic acids are named by adding the suffix –oic acid.** The prefixes are again determined by the amount of carbon atoms in the chain as

explained in step 4. If there are any side chains, the main chain should be numbered starting at the functional group.

10. **Esters are named using a side branch** as well as the main chain as the – **noate**. The chain is divided by the presence of an oxygen atom in the chain. The portion of the molecule containing both oxygen atoms is the main chain and the other portion serves as the side chain.

NOTE THE FOLLOWING:

- ALL HYDROCARBONS WILL UNDERGO COMBUSTION/OXIDATION
- ALL SATURATED ORGANIC MOLECULES (**ALKANES,ALCOHOLS,HALOALKANES**) WILL UNDERGO SUBSTITUTION AND ELIMINATION
- UNSATURATED HYDROCARBONS WILL UNDERGO ADDITION REACTIONS (HYDROGENATION,HYDRATION,HALOGENATION AND HYDROHALOGENATION) NB****ADDITION REACTIONS OF ALKYNES ARE NOT EXAMINABLE**
- **ESTERIFICATION/CONDENSATION** - REACTION BETWEEN A PRIMARY ALCOHOLS AND CARBOXYLIC ACIDS.WRITE THE ALCOHOL AS IS AND THE CARBOXYLIC ACID FROM THE RIGHT TO THE LEFT

MULTIPLE CHOICE QUESTIONS

QUESTION 1

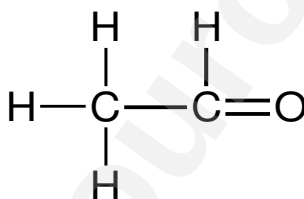
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 $C_nH_{2n+1}OH$ is the GENERAL FORMULA for ...

- A Alkanes.
- B Aldehydes.
- C Alcohols.
- D Alkenes.

(2)

1.2 Consider the structural formula of an organic compound below.



Which ONE of the following is the correct IUPAC name of this compound?

- A Ethanone
- B Ethene.
- C Ethanol
- D Ethanal.

(2)

1.3 Which ONE of the following reaction types can be used to prepare ETHENE from ETHANE?

- A Hydrogenation
- B Substitution
- C Dehydrogenation
- D Addition

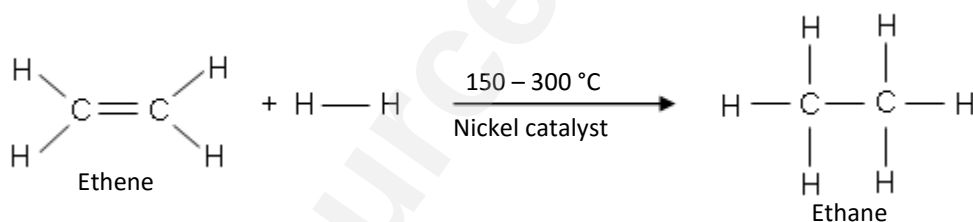
(2)

1.4 The correct systematic name for $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)=\text{C}(\text{CH}_2\text{CH}_3)\text{CH}_3$ is

- A 2,3-diethylbut-2-ene
- B 2-ethyl-3-methylpent-2-ene
- C 4-ethyl-3-methylpent-3-ene
- D 3,4-dimethylhex-3-ene

(2)

1.5 The reaction below represents



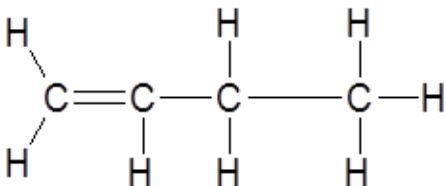
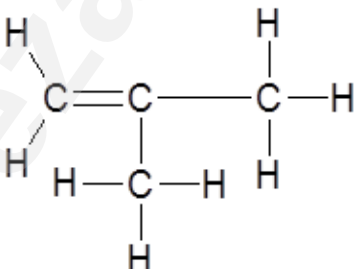
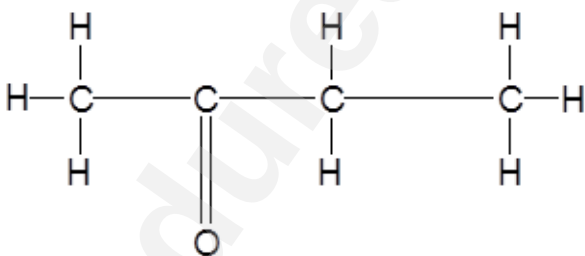
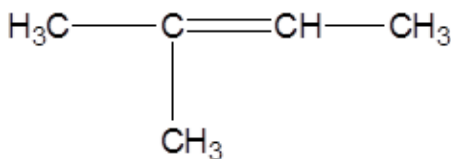
- A halogenation
- B hydration
- C hydrolysis
- D hydrogenation

(2)

[10]

QUESTION 2

Consider the organic compounds represented by the letters **A** to **G** in the table below:

A 		B 	
C But-2-ene	D $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$	E Methyl propanoate	
F 		G 	

2.1 Define the term **hydrocarbon**. (2)

2.2 Write down the LETTER that represents...

2.2.1 a chain isomer of compound A. (1)

2.2.2 a positional isomer of compound A. (1)

- 2.2.3 a functional isomer of compound D. (1)
- 2.3 Define the term **structural isomer**. (2)
- 2.4 Write down the IUPAC name of compound B. (2)
- 2.5 Write down the molecular formula of compound C. (1)
- 2.6 Write down the structural formula of compound **E**. (2)
- 2.7 Write down the structural formula for the functional group of compound C. (1)

QUESTION 3

A learner conducts a scientific investigation to compare the boiling points of organic compounds belonging to different homologous series. Propan-1-ol, ethanoic acid and propanal are used for the investigation. His results are shown in the table below.

Compound	Boiling point c
Compound A	48
Compound B	97
Compound C	118

- 3.1 For this investigation, name the ...
- 3.1.1 independent variable. (1)
- 3.1.2 dependent variable. (1)
- 3.2 Will the vapour pressure of propanal be LOWER or HIGHER than the vapour pressure of propan-1-ol? Explain your answer by referring to the type of INTERMOLECULAR FORCES present and ENERGY. (4)
- 3.3 Identify:
- 3.3.1 Compound A (1)
- 3.3.2 Compound B (1)
- 3.3.3 Compound C (1)
- 3.4 Will the boiling point of butan-1-ol be HIGHER or LOWER than the boiling point of propan-1-ol? Explain the answer referring to the INTERMOLECULAR FORCES. (2)

[11]

The letters **A** to **H** represent eight organic compounds.

4.1 Write down the letter(s) that represent(s) each of the following:

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(A compound may be used more than once.)

4.1.1 An aldehyde (1)

4.1.2 A compound containing the carbonyl group as a functional group (1)

4.1.3 A tertiary alcohol (1)

4.2 Write down:

4.2.1 the IUPAC name of compound **A** (2)

4.2.2 the NAME of the functional group of compound **C** (1)

4.2.3 the STRUCTURAL FORMULA of the substituent (side chain) of compound **D** (2)

4.2.4 ONE use of compound **F** (1)

4.2.5 the STRUCTURAL FORMULA of compound **D** (2)

QUESTION 5

Three hydrocarbons (A, B and C) with a molecular formula C_5H_{12} are used to investigate the effect of **branched chains** on the **boiling point** of hydrocarbons. The results obtained are given in the table below.

(2)

HYDROCARBON	BOILING POINT (°C)
A	36
B	28
C	10

(1)

5.1 Are these hydrocarbons saturated or unsaturated? Explain the answer. (2)

5.2 ONE of the hydrocarbons (**A**, **B** or **C**) has an unbranched chain. (3)

5.2.1 Write down the letter (**A**, **B** or **C**) that represents this hydrocarbon.

5.2.2 Give a reason why the above-mentioned compounds are considered to be **chain isomers**.

5.3 Explain why hydrocarbon **C** has the lowest boiling point. In the explanation refer to the MOLECULAR STRUCTURE of compound **C**, INTERMOLECULAR FORCES and the ENERGY required.

QUESTION 6

The letters A to D in the table below represent four organic compounds.

A	$ \begin{array}{ccccccc} & \text{H} & & \text{CH}_3 & & \text{H} & & & & \text{H} \\ & & & & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} \equiv \text{C} & - & \text{C} - \text{H} \\ & & & & & & & & & \\ & \text{CH}_3 & & \text{H} & & \text{CH}_2\text{CH}_3 & & & & \text{H} \end{array} $	B	$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{O} & & \text{H} \\ & & & & & & & \\ \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} - \text{H} \\ & & & & & & & \\ & \text{H} & & \text{H} & & & & \text{H} \end{array} $
C	$\text{CH}_3\text{CH}_2\text{CHO}$	D	Butane

Use the information in the table to answer the questions that follow.

- 6.1 Write down the:
- 6.1.1 Letter that represents a ketone (1)
 - 6.1.2 Structural formula of the functional group of compound C (1)
 - 6.1.3 General formula of the homologous series to which compound A belongs (1)
 - 6.1.4 IUPAC name of compound A (3)
 - 6.1.5 IUPAC name of compound B (2)
- 6.2 Compound D is a gas used in cigarette lighters.
- 6.2.1 To which homologous series does compound D belong? (1)
 - 6.2.2 Write down the STRUCTURAL FORMULA and IUPAC NAME of a structural isomer of compound D. (4)
 - 6.2.3 Is the isomer in QUESTION 5.2.2 a CHAIN, POSITIONAL or FUNCTIONAL isomer? (1)
- 6.3 Compound D reacts with bromine (Br_2) to form 2-bromobutane.
Write down the name of the:
- 6.3.1 Homologous series to which 2-bromobutane belongs (1)
 - 6.3.2 Type of reaction that takes place (1)

[16]

QUESTION 7

7.1 Consider the organic compounds represented by the letters **A** to **F** in the table below.

A	2,2,4-trimethylhexane	B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO}$
C		D	
E		F	Pentan-2-one

Write down the LETTER that represents the following:

- 7.1.1 An aldehyde (1)
 7.1.2 A condensation polymer (1)
 7.1.3 A compound which has a carbonyl group bonded to two carbon atoms as its functional group (1)
 7.2 Write down the IUPAC name of:
 7.2.1 Compound C (3)
 7.2.2 The monomer of compound D (1)
 7.3 Write down the structural formula of:
 7.3.1 Compound A (2)
 7.3.2 Compound F (2)
 7.4 The table contains compounds which are functional isomers.
 7.4.1 Define the term functional isomer. (2)
 7.4.2 Write down the LETTERS that represent two compounds that are functional isomers. (1)

[14]

QUESTION 8

The letters **P** to **U** in the table below represent six organic compounds.

P	$ \begin{array}{ccccccc} & \text{H} & & \text{H} & & & \\ & & & & & \text{H} & \text{H} \\ \text{H} & - \text{C} & - & \text{C} = & \text{C} & - & \text{C} - & \text{C} - & \text{H} \\ & & & & & & & \\ & \text{H} & & & & \text{H} & \text{H} & \text{H} \end{array} $	Q	Methylpropanoate
R	3-Methylbutan-2-ol	S	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
T	$ \begin{array}{ccccccc} & & & \text{H} & & & \\ & & & & & & \\ & & \text{H} & - & \text{C} & - & \text{H} \\ & & & & & & \\ & \text{H} & & & & \text{Br} & & \text{Br} & & \text{H} \\ & & & & & & & & & \\ \text{H} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} - & \text{H} \\ & & & & & & & & & \\ & \text{H} & & & & \text{H} & & \text{H} & & \text{H} \\ & & & \text{H} & - & \text{C} & - & \text{H} \\ & & & & & & \\ & & & \text{H} & & & \end{array} $	U	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COCH}_2\text{CH}_3$

- 8.1 Write down the LETTER(S) that represent(s) the following:
(A compound/ letter may be used more than once)
- 8.1.1 A ketone. (1)
- 8.1.2 A carboxylic acid (1)
- 8.1.3 A compound with the general formula C_nH_{2n} (1)
- 8.1.4 Two compounds that are FUNCTIONAL ISOMERS. (1)
- 8.2 Write down the IUPAC name of compound:
- 8.2.1 **T** (3)
- 8.2.2 **U** (2)
- 8.3 Write down the STRUCTURAL FORMULA of compound:
- 8.3.1 **Q** (2)
- 8.3.2 **R** (2)
- 8.4 Compound **R** is a secondary alcohol. Explain the validity of this statement. (1)

SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2016



GRADE 12

PHYSICAL SCIENCE

MEMORANDUM: ORGANIC CHEMISTRY

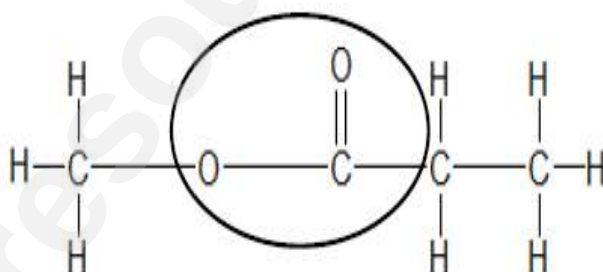
SESSION 3

QUESTION 1

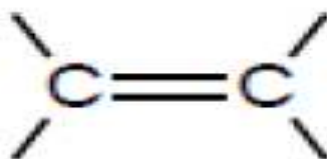
- | | | |
|-----|-----|-------------|
| 1.1 | C✓✓ | (2) |
| 1.2 | D✓✓ | (2) |
| 1.3 | C✓✓ | (2) |
| 1.4 | D✓✓ | (2) |
| 1.5 | D✓✓ | (2) |
| | | [10] |

QUESTION 2

- | | | |
|-------|---|-----|
| 2.1 | Organic compounds that consist of hydrogen and carbon only. ✓✓ | (2) |
| 2.1.1 | B ✓ | (1) |
| 2.2.2 | C ✓ | (1) |
| 2.2.3 | E ✓ | (1) |
| 2.3 | Organic molecules with the same molecular formula, but different structural formulae ✓✓ | (2) |
| 2.4 | 2-methylprop-1-ene ✓✓ (Double bond correctly named ✓ side chain correctly named ✓) | (2) |
| 2.5 | C ₄ H ₈ ✓ | (1) |



- | | | |
|-----|--|-----|
| 2.6 | functional group ✓ rest of molecule ✓. | (2) |
| 2.7 | ✓ | (1) |



- 2.8 Butanoic acid ✓ (1)
- 2.9 unsaturated ✓ Compounds with one or more multiple bonds between C atoms ✓ in their hydrocarbon chains.
ANY ONE
 · It does not ONLY have single bonds.
 · It does not have single bonds between all C atoms.
 · It has double bonds between C atoms.
 · It does not contain the maximum number of H atoms bonded to C atoms.
 · Each C atom in B is not bonded to four other atoms. (2)
- 2.10 alkenes ✓ (1)
- [18]

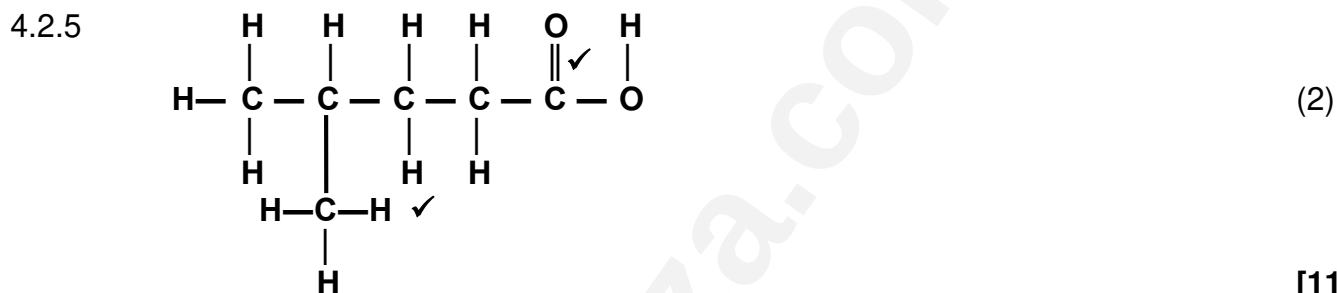
QUESTION 3

- 3.1.1 Different functional group/homologous series ✓ (1)
- 3.1.2 Boiling point ✓ (1)
- 3.2 Higher ✓ Between the particles of propan-1-ol there are hydrogen bonds and between the particles of propanal there are London forces (induced dipole forces) ✓. Hydrogen bonds are stronger than London forces ✓ Hydrogen bonds require more energy to overcome than London forces. ✓ (4)
- 3.3.1 A propanal ✓ (1)
- 3.3.2 B - propan-1-ol ✓ (1)
- 3.3.3 C ethanoic acid ✓ (1)
- 3.4 HIGHER, ✓ the van der Waals forces increases with increasing molecular mass or the longer the carbon chain/greater the surface area, the greater stronger the London forces will become. (2)

QUESTION 4

- 4.1
- 4.1.1 H ✓ (1)
- 4.1.2 E ✓ (1)
- 4.1.3 B ✓ (1)
- 4.2
- 4.2.1 3-chloro ✓ hexane ✓ (2)
- 4.2.2 Carbon-carbon double bond ✓ (1)
- 4.2.3
- $$\begin{array}{c} \text{H} \\ | \\ \text{H} - \text{C} - \text{H} \\ | \\ \text{H} \end{array}$$
- (2)

- 4.2.4 Responsible for some fruity flavours/ fragrances (in wines, food, cosmetics)✓
Play a role in insect communication ✓ (1)
Some esters have anaesthetic properties ✓
Medicine preparation ✓
Plexiglas is a transparent plastic of long chain esters (polyesters)



QUESTION 5

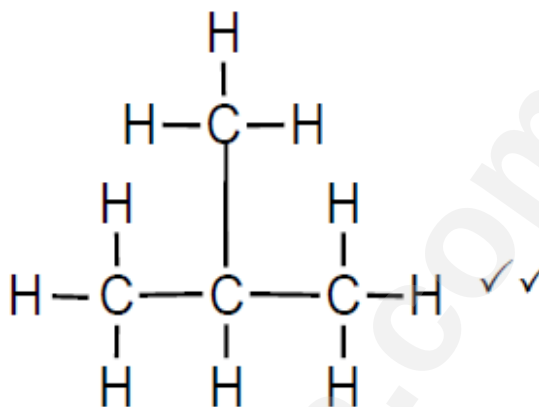
- 5.1.1 Different functional group/homologous series✓ (1)
 5.1.2 Boiling point ✓ (1)
 5.2 Higher, ✓ between the particles of propan-1-ol there are hydrogen bonds and between the particles of propanal there are London forces (induced dipole forces) ✓
 .Hydrogen bonds are stronger than London forces✓ Hydrogen bonds require more energy to overcome than London forces. ✓ (4)
 5.3.1 A-propanal ✓ (1)
 3.3.2 B - propan-1-ol ✓ (1)
 5.3.3 C-ethanoic acid ✓ (1)
 5.4 HIGHER, ✓ the strength of London forces increases with increase in molecular mass✓
 OR
 HIGHER, ✓ the longer the carbon chain/greater the surface area, the greater stronger the London forces will become. ✓ (2)
 [11]

QUESTION 6

- 6.1.1 B
- $$\begin{array}{c}
 \text{O} \\
 || \\
 -\text{C}-\text{H} \quad \checkmark
 \end{array}$$
- 6.1.2 (1)
 6.1.3 $\text{C}_n\text{H}_{2n-2}$ (1)
 6.1.4 4-ethyl-5-methylhept-2-yne / 4-ethyl-5-methyl-2-heptyne (3)

6.1.5 butan-2-one / 2-butanone / butanone (2)

6.2.1 Alkanes (1)



6.2.2 2-methylpropane (4)

6.2.3 chain (1)

6.3.1 haloalkanes / alkyl halides (1)

6.3.2 substitution / halogenation / bromonation (1)

[16]

QUESTION 7

7.1 (1)

7.1.1 B (1)

7.1.2 E (1)

7.1.3 F (1)

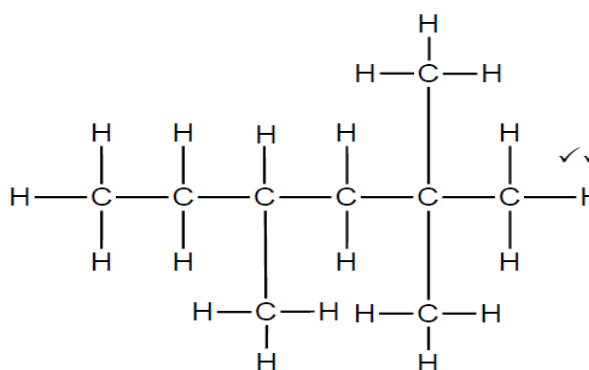
7.2

7.2.1 2-bromo-3-chloro-4-methylpentane (3)

7.2.2 Ethene (1)

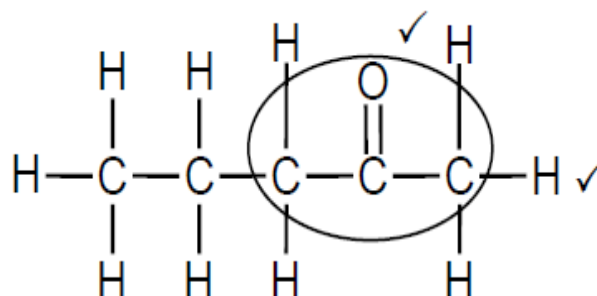
7.3

7.3.1



(2)

7.3.2



(2)

7.4

7.4.1 (Compounds with) the same molecular formula but different functional groups / different homologous series. (2)

7.4.2 B & F

(1)

[14]

QUESTION 8

8.1

8.1.1 U✓

(1)

8.1.2 S✓

(1)

8.1.3 P✓

(1)

8.1.4 Q and S✓

(1)

8.2

8.2.1 2,2-Dibromo-4,4-dimethylpentane

Marking Criteria:

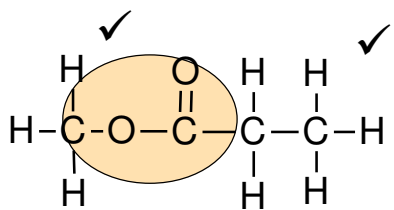
- Correct stem i.e pentane✓
- All substituents correctly identified✓
- Substituent correctly numbered, in alphabetical order, hyphens and commas correctly used✓

(3)

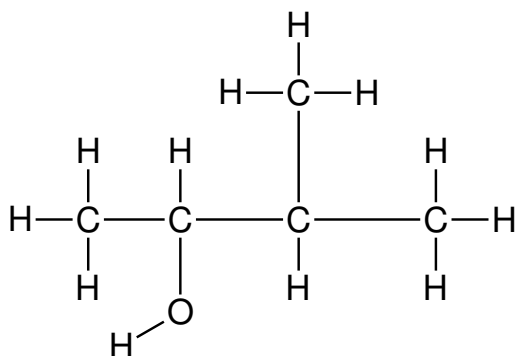
8.2.2 Hexan-3-one

8.3

8.3.1



8.3.2



Marking criteria

- Four saturated C atoms in longest chain i.e. butane✓
- Methyl substituent on third C and –OH group on second C✓

(2)

8.4

The carbon atom that bears the –OH group is bonded to only two alkyl groups.✓

(1)

[14]

SECONDARY SCHOOL IMPROVEMENT PROGRAMME (SSIP) 2016



GAUTENG PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

SUBJECT: PHYSICAL SCIENCE

ORGANIC REACTIONS

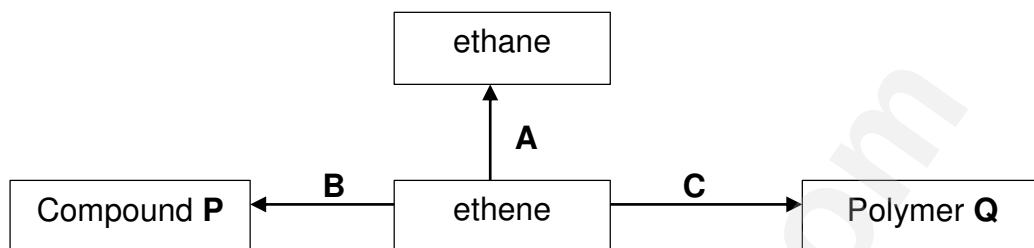
SESSION 4

NOTE THE FOLLOWING:

- ALL HYDROCARBONS WILL UNDERGO COMBUSTION/OXIDATION
- ALL SATURATED ORGANIC MOLECULES (ALKANES,ALCOHOLS,HALOALKANES) WILL UNDERGO SUBSTITUTION AND ELIMINATION
- UNSATURATED HYDROCARBONS WILL UNDERGO ADDITION REACTIONS (HYDROGENATION,HYDRATION,HALOGENATION AND HYDROHALOGENATION) NB** **ADDITION REACTIONS OF ALKYNES ARE NOT EXAMINABLE**
- **ESTERIFICATION/CONDENSATION** - REACTION BETWEEN A PRIMARY ALCOHOLS AND CARBOXYLIC ACIDS.WRITE THE ALCOHOL AS IS AND THE CARBOXYLIC ACID FROM THE RIGHT TO THE LEFT

QUESTION 1

The flow diagram below shows how some organic compounds can be prepared from ethene. A, B and C represent different organic reactions.



1.1

For reaction **A**, write down:

- | | | |
|-------|---|-----|
| 1.1.1 | The FORMULA or NAME of the other reagent needed | (1) |
| 1.1.2 | The type of addition reaction | (1) |
| 1.1.3 | The FORMULA or NAME of the catalyst used | (1) |
| 1.1.4 | One use of the reaction in the FOOD industry. | (1) |

1.2

Reaction **B** takes place when ethene reacts with hydrogen bromide (HBr).

For this reaction, write down the:

- | | | |
|-------|--|-----|
| | | (1) |
| 1.2.1 | Name of the reaction that takes place | (4) |
| 1.2.2 | Balanced equation using structural formulae | |
| 1.2.3 | Name of the homologous series to which compound P belongs | (1) |

1.3

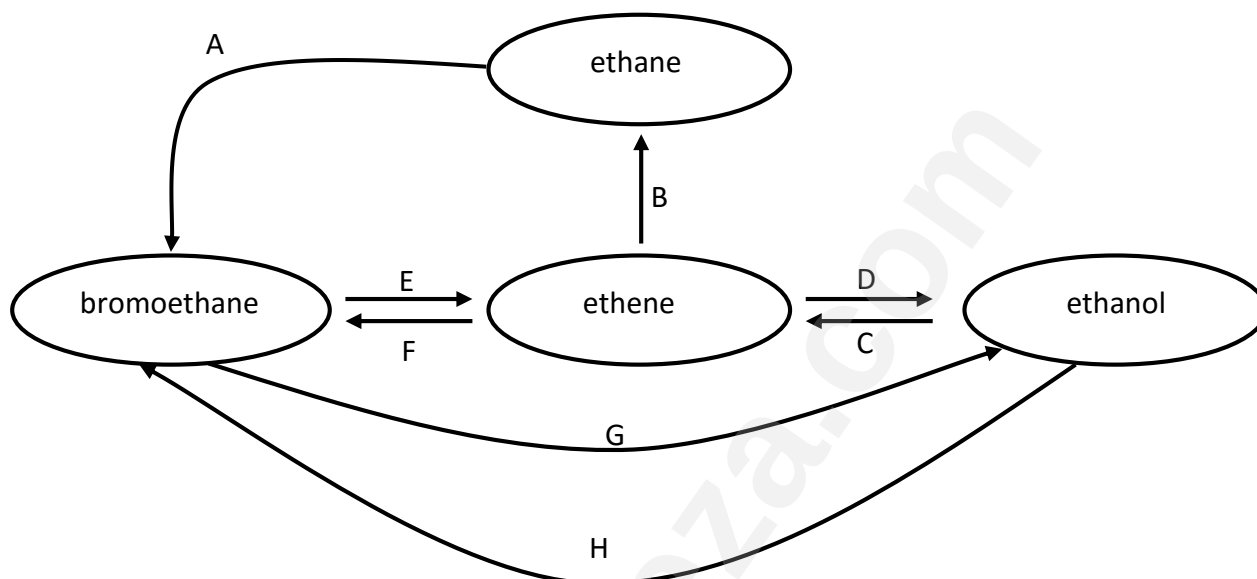
Consider reaction **C**.

- | | | |
|-------|--|------------|
| 1.3.1 | Ethene is a monomer of compound Q . Explain clearly what this statement means. | (2) |
| 1.3.2 | Reaction C is an example of polymerisation reactions. Name the type of polymerisation of which reaction C is an example. | (1)
(2) |
| 1.3.3 | Write down the STRUCTURAL FORMULA of polymer Q indicating ONLY two repeating units. | |

[15]

QUESTION 2

The flow diagram below illustrates some of the many reactions ethene undergoes.

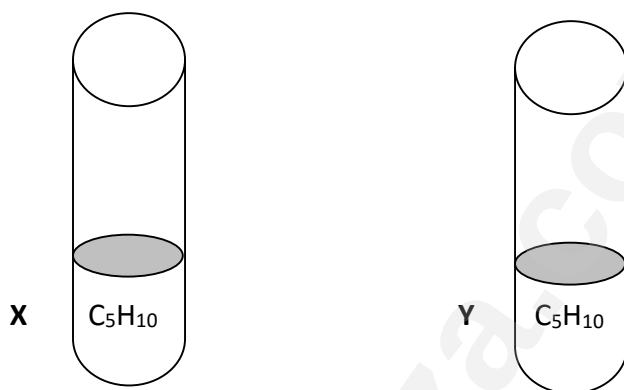


- 2.1 Write down the structural formula of ethane (2)
- 2.2 Why is it not advisable to place a banana that has been artificially ripened alongside a cabbage and lettuce? (2)
- 2.3 Write down the general formula for the homologous series to which ethene belongs. (1)
- 2.4 Name the type of reaction represented by each of the letters A, B, D and H. Write down the letters A, B, D and H and next to each the type of reaction. (4)
- 2.5 Use structural formulae to write down a balanced equation for reaction B. (3)
- 2.6 Apart from ethene, which other reactant is needed for reaction F? Write down the FORMULA only. (2)
- 2.7 Both reactions E and G occur in the presence of a base. Reaction E is an elimination reaction and reaction G is a substitution reaction.
- 2.7.1 How is the base in reaction E different from the base in reaction G? (2)
- 2.7.2 Name the type of elimination reaction represented by E. (1)
- [17]**

QUESTION 3

You have two test tubes containing equal amounts of compounds X and Y respectively. Both have the same molecular formula C_5H_{10} . You have to distinguish which compound, X or Y, is saturated.

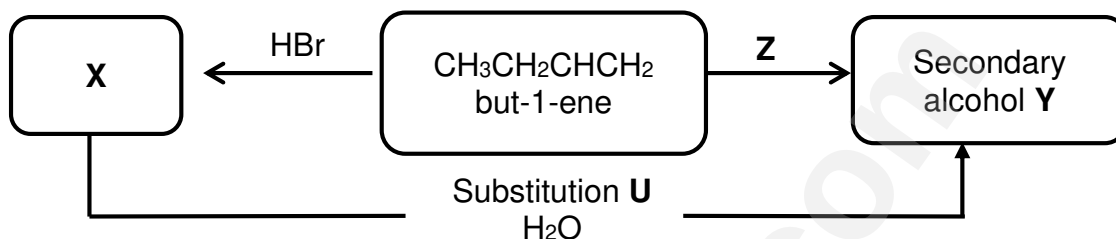
You hypothesise that compound X is saturated.



- 3.1 Design an investigation to show that your hypothesis is true. Use the following to write down your design (write only the question number and next to it your answer):
- 3.1.1 Write down your investigative question. (2)
- 3.1.2 Write down a list of apparatus and chemicals you will use. (2)
- 3.1.3 State the safety precautions that you will take. (2)
- 3.1.4 Write down the procedure you will follow. (4)
- 3.2 Describe how you will use your observations to verify your hypothesis. (2)
- 3.3 Write down the IUPAC name of compound Y. (2)
- [14]**

QUESTION 4 : (Start on a new page)

In industry alkenes are used in the synthesis of a variety of organic compounds. The flow diagram below illustrates some of the many possible reactions.



- 4.1 Use structural formulae to write a balanced equation for the formation of COMPOUND **X**. (4)
- 4.2 Name the type of reaction that takes place when but-1-ene is converted to COMPOUND **X**. (1)
- 4.3 Write down the structural formula and IUPAC name of the SECONDARY ALCOHOL **Y**, that is formed. (3)
- 4.4 Name the type of substitution reaction **U** that takes place when COMPOUND **X** is converted to the SECONDARY ALCOHOL **Y**. (1)
- 4.5 With the aid of a catalyst, but-1-ene can be converted directly to the secondary alcohol, without the formation of the intermediate compound **X**.
- 4.5.1 Besides but-1-ene, write down the NAME of the other reactant needed for this reaction **Z**. (1)
- 4.5.2 Write down the FORMULA of the catalyst that can be used. (1)
- 4.5.3 Name the type of REACTION **Z** that will take place during this direct conversion. (1)
- 4.6 Instead of adding water to compound **X**, concentrated sodium hydroxide is added and the mixture is heated.
- 4.6.1 Write down the IUPAC name of the organic product that is formed. (1)
- 4.6.2 Name the TYPE of reaction that takes place. (1)

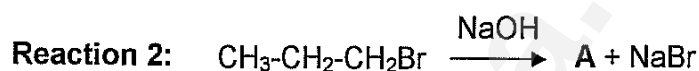
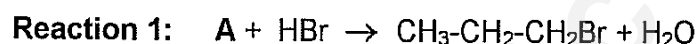
QUESTION 5

5.1 Write down the structural formulae and IUPAC names for the product(s) formed when the following compounds react with each other:

5.1.1 cyclohexene and HCl (3)

5.1.2 $\text{CH}_3\text{---CH}_2\text{---}\underset{\text{CH}_3}{\text{C}}\text{=CH---CH}_3$ and HBr (3)

5.2 The following equations represent chemical reactions:



5.2.1 Name the type of reaction in reaction 2. (1)

5.2.2 Write down the structural formula for the organic compound A. (2)

5.3 Cracking is a process that is generally used in the oil industry.

5.3.1 What is meant by *cracking*? (2)

5.3.2 Why is cracking used in the fuel industry? (2)

5.3.3 Give a reason for the difference in the melting and boiling points of the following two compounds, produced from a specific cracking process:

COMPOUND	MELTING POINT (°C)	BOILING POINT (°C)
Butane	-138	-1
Heptane	-91	89

5.3.4 In which phase (gas, liquid or solid) is each of the following when used as a fuel: (2)

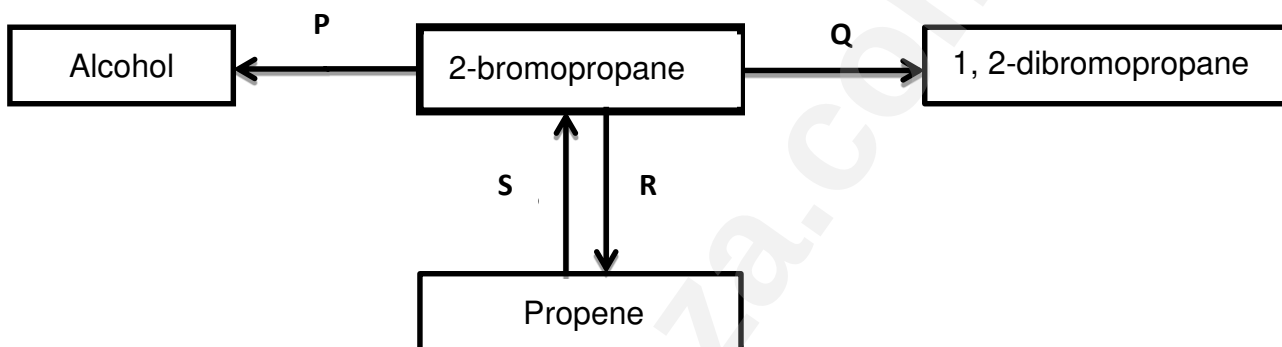
(a) Butane

(b) Heptane

(2)
[17]

QUESTION 6 (Start on a new page.)

The flow diagram below shows various chemical reactions of haloalkanes. P, Q and R represent reaction types.



6.1 Write down the type of reaction represented by:

6.1.1 **Q** (1)

6.1.2 **R** (1)

6.2 For reaction **P**, write down the following:

6.2.1 The structural formula of the alcohol formed (2)

6.2.2 The IUPAC name of the alcohol formed (1)

6.3 In reaction **S**, propene reacts with compound X to form 2-bromopropane.

Write down the:

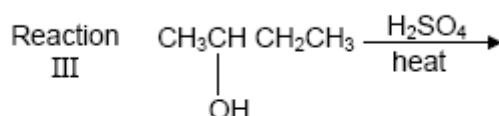
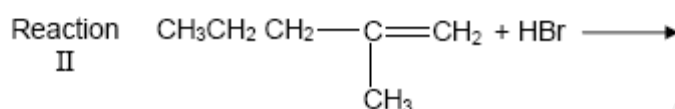
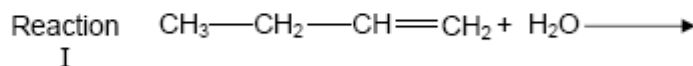
4.3.1 **NAME** of compound X (1)

4.3.2 Balanced equation using structural formulae (4)

[10]

QUESTION 7

Most organic compounds can undergo substitution or addition or elimination reactions to produce a variety of organic compounds. Some incomplete organic reactions are represented below.



- 7.1 Name the type of reaction represented by reaction III. (1)
- 7.2 Both reactions I and II are examples of addition reactions. Name the type of addition that is represented by each reaction. (2)
- 7.3 Write down the structural formula and IUPAC name of the major product formed in reaction I. (3)
- 7.4 Reaction I only takes place in the presence of a catalyst. Write down the formula of the catalyst used in reaction I. (1)
- 7.5 Write down the structural formula and IUPAC name of the major product formed in reaction II. (3)
- 7.6 To which homologous series does the organic product formed in reaction III belong? (2)
- [12]**

QUESTION 1

1.1

1.1.1 H₂/ Hydrogen (gas)✓

Accept:

Dihydrogen

(1)

1.1.2 (catalytic) hydrogenation✓

(1)

1.1.3 Pd (Palladium)✓

OR

Ni (Nickel)

OR

Pt (Platinum)

(1)

1.1.4 In the manufacture of margarine✓

(1)

1.2

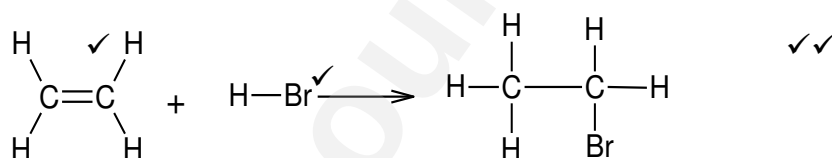
1.2.1 Addition ✓

Accept:

Hydrohalogenation/ Hydrobromination

(1)

1.2.2



(4)

1.2.3 Halo-alkanes/ Halogenoalkanes/ Alkylhalides✓

Accept:

Organic halides

(1)

1.3

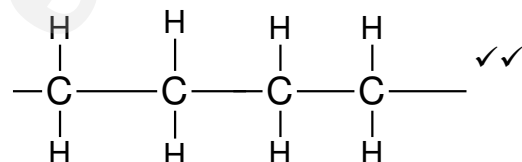
1.3.1 Ethene molecules combine to form the repeating unit of compound Q, a polymer.✓✓

(2)

1.3.2 Addition ✓

(1)

1.3.3



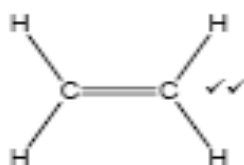
(2)

[15]

QUESTION

2.

2.1



[12.2.3] (2)

2.2

The ethene liberated by the banana ages the cabbage and lettuce. ✓✓
 Die eteen wat deur die piesang vrygestel is, verouder die kool en die blaarslaai.

[12.3.2] (2)

2.3

 C_nH_{2n} ✓

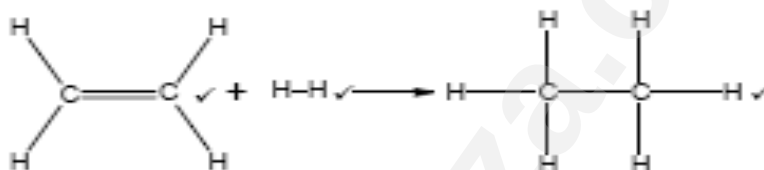
[12.2.1] (1)

2.4

A: substitution (halogenation/bromination) / substitusie (halogenering / brominering) ✓
 B: addition (hydrogenation) / addisie (hidrogenering) ✓
 D: addition (hydration) / addisie (hidrasie/hidrenering) ✓
 H: substitution / substitusie ✓

[12.1.2] (4)

2.5



[12.2.3] (3)

2.6

HBr ✓✓

(Hydrogen bromide – one mark / Waterstofbromied – een punt)

[12.1.2] (2)

2.6.1

E: concentrated / gekonsentreerd ✓
 G: dilute / verdund ✓

OR/OF

Base is more concentrated in reaction E than in reaction G or base is less concentrated in reaction G than in reaction E ✓✓

Basis is meer gekonsentreerd in reaksie E as in reaksie G of basis is minder gekonsentreerd in reaksie G as in reaksie E

OR/OF

Base in reaction E is dissolved in ethanol (no water added) ✓✓

Basis in reaksie E is in etanol opgelos (geen water nie)

[12.1.2] (2)

2.6.2

Dehydrohalogenation/Dehidrohalogenering ✓

[12.1.2] (1)

[17]

QUESTION 3

3.1.1

Investigative question / Onderzoekende vraag:

Which one of the two compounds (X and Y) is saturated / unsaturated?

✓✓

Watter een van die verbindings (X en Y) is versadig / onversadig?

OR/OF

Is X saturated?

Is X versadig?

No marks if an aim or hypothesis is stated / Geen punte as stelling of hipotese gegee word

[12.1.1]

TEST FOR SATURATION USING BROMINE/IODINE
TOETS VIR VERSADIGING DEUR VAN BROOM/JODIUM GEBRUIK TE MAAK

3.1.2

Apparatus and chemicals/Apparaat en chemikalieë:

Bromine water(solution) / Br₂ or iodine (solution) / I₂ ✓Broomwater(oplossing)/ Br₂ of jodium / I₂(oplossing)

Test tubes / suitable containers / measuring cylinder / dropper ✓

Proefbuise/geskikte houers/maatsilinder/drupper

[12.1.1]

3.1.3

Safety precautions/Veilighheidsmaatreëls:

- Protective clothing : Use gloves / Avoid contact with skin/ goggles. Gebruik handskoene/ vermy kontak met die vel / veiligheidsbrille ✓
- Work in fume cupboard / mask (well ventilated room / outside) / Do not inhale ✓ Werk in 'n dampkas/masker (goed geventileerde vertrek/werk buitekant) / Moenie inasem nie
- No open flames/Geen oop vlamme nie

[12.1.1]

3.1.4.

Procedure / Prosedure (4 marks):

- Add bromine water / iodine solution (iodine) ✓
- to each of compounds X and Y in the test tubes ✓
- Compare / note / record/ observe ✓ the (rate of) colour change ✓ (decolourisation) for the two compounds.
- Voeg broomwater/jodiumoplossing (jodium)
- by elk van verbindings X en Y in die proefbuise
- Vergelyk / noteer/ skryf neer die (tempo van) kleurverandering (ontkleuring) vir die twee verbindings.

[12.1.1]

3.2

SATURATION TEST / TOETS VIR VERSADIGING

The solution that shows a rapid colour change is unsaturated. ✓✓ / Die oplossing wat 'n kleurverandering toon, is onversadigd.

OR/OF

The solution that shows no or a slow rate of colour change (no reaction takes place) is saturated. ✓✓ / Die oplossing wat geen of stadige tempo van kleurverandering toon (geen reaksie vind plaas), is versadigd.

BOILING POINT METHOD

The compound which has the higher boiling point is saturated ✓✓ / Die verbinding met die hoogste kookpunt is versadig

OR/OF

The compound with the lower boiling point is unsaturated ✓✓ / Die verbinding met die laer kookpunt is onversadig

[12.1.2]

(2)

3.3

Any one/Enigeen

1-pentene / pent-1-ene / 1-penteen / pent-1-ene ✓✓

OR/OF

2-pentene / pent-2-ene / 2-penteen / pent-2-ene

OR/OF

3-methyl-1-butene / 3-methylbut-1-ene

3-metiel-1-buteen/3-metielbut-1-ene

OR/OF

2-methyl-1-butene / 2-methylbut-1-ene

2-metiel-1-buteen/2-metielbut-1-ene

OR/OF

2-methyl-2-butene / 2-methylbut-2-ene

2-metiel-2-buteen/2-metielbut-2-ene

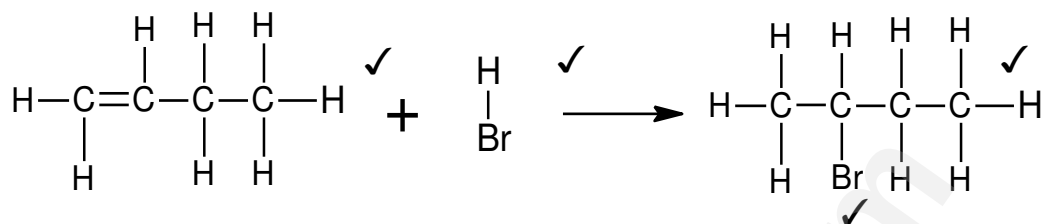
[12.2.3]

(2)

[14]

QUESTION 4 / VRAAG 4

4.1

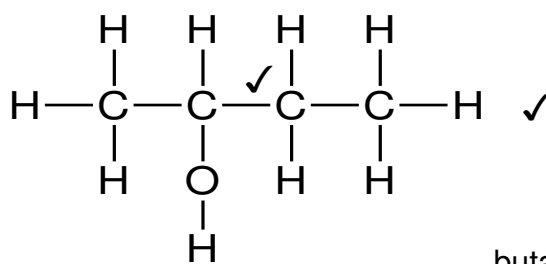


(4)

4.2 Hydrohalogenation / addition ✓ / hidrohalogenering / addisie ✓

(1)

4.3



butan-2-ol (2-butanol) ✓

(3)

4.4 hydrolysis / hidrolise ✓

(1)

4.5.1 Water / H₂O ✓

(1)

4.5.2 H₂SO₄ / HCl / H₃PO₄ ✓

(1)

4.5.3 Hydration / hidrasie ✓ (accept addition / aanvaar addisie) ✓

(1)

4.6.1 but-2-ene/2-butene ✓ / but-2-een / 2-buteen ✓

(1)

4.6.2 Dehydrohalogenation / elimination ✓

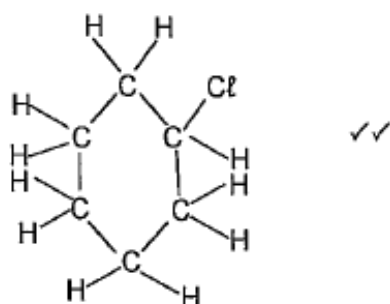
Dehidrohalogenering / eliminasie ✓

(1)

[14]

Q5, P2, Preparatory, 2008

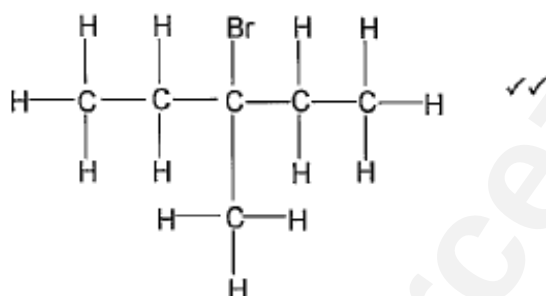
5.1.1



Chlorohexane/chloorheksaan ✓

[12.2.3] (3)

5.1.2



3-bromo 3-methylpentane/3-broom 3-metiehpentaaan ✓

[12.2.3] (3)

5.2.1 Substitution / substitusie ✓

[12.2.3] (1)

5.2.2 $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{OH}$ ✓✓

[12.2.3] (2)

5.3.1 Dividing longer chains of hydrocarbons into shorter chains ✓✓
Verdeel langer kettings van koolwaterstowwe in korter kettings

[12.2.1] (2)

5.3.2 To obtain a larger percentage usable products from larger fractions crude oil ✓✓/ shorter chains (which burn more evenly) / shorter chains are blended with fuel to enrich fuel
Om 'n groter persentasie bruikbare produkte van groter fraksies van ru-olie te verkry/ korter kettings brand meer egalig / korter kettings word met brandstof gemeng om dit te verryk

[12.3.2] (2)

5.3.3 Boiling point increases with increasing molecular mass. ✓ Van der Waals forces increases with increasing molecular mass ✓
Kookpunte neem toe met toenemende molekulêre massa. Van der Waalskragte neem toe met toenemende molekulêre massa

[12.2.2] (2)

5.3.4 (a) gas ✓
(b) liquid / vloeistof ✓

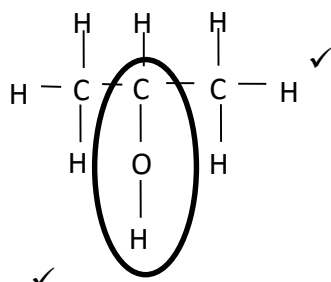
[12.2.2] (2)
[17]

QUESTION 6

6.1.1 **Q:** Substitution✓/halogenation/chlorination (1)

6.1.2 **R:** Elimination/ dehydrohalogenation/ dehydrobromination✓ (1)

6.2.1



- Functional group
- Whole structure correct

Accept –OH condensed in structural formula

(2)

Condensed/semi – structural formulae Max: $\frac{1}{2}$

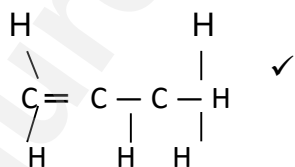
Molecular formula $\frac{0}{2}$

6.2.2 Propan – 2 – ol ✓ (1)

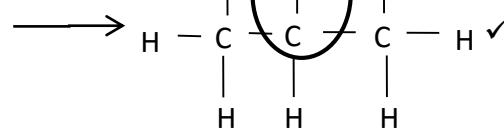
2-propanol

6.3.1 Hydrogen bromide ✓ (1)

6.3.2



+ H – Br ✓



P2, Supplementary, 2009

QUESTION 7/VRAAG 7

- 7.1 III - elimination/dehydration ✓
eliminasi/dehidrasi [12.1.2] (1)
- 7.2 I – hydration / *hidrasi* ✓
II – hydrohalogenation / *hidrohalogenasi* ✓ [12.1.2] (2)
- 7.3
- $$\begin{array}{ccccccc}
 & \text{H} & & \text{H} & & \text{H} & & \text{H} \\
 & | & & | & & | & & | \\
 \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \text{H} \\
 & | & & | & & | & & | \\
 & \text{H} & & \text{H} & & \text{OH} & & \text{H}
 \end{array}$$
- ✓✓
- 2-butanol/butan-2-ol ✓ [12.2.3] (3)
- 7.4 H_2SO_4 ✓ [12.2.1] (1)
- 7.5
- $$\begin{array}{ccccccc}
 & \text{H} & & \text{H} & & \text{H} & & \text{Br} & & \text{H} \\
 & | & & | & & | & & | & & | \\
 \text{H} & - \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - \text{H} \\
 & | & & | & & | & & | & & | \\
 & \text{H} & & \text{H} & & \text{H} & & \text{H} & & \text{H} \\
 & & & & & & & | & & \\
 & & & & & & & \text{H} - \text{C} - \text{H} \\
 & & & & & & & | \\
 & & & & & & & \text{H}
 \end{array}$$
- ✓✓
- 2-bromo-2-methylpentane ✓
2-bromo-2-metielpentaaan/2-broom-2-metielpentaaan [12.2.3] (3)
- 7.6 Alkenes/alkene ✓✓ [12.2.3] (2)

[12]