basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

NOVEMBER 2013

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2. Answer ALL the questions in the ANSWER BOOK.

3. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

4. You may use a non-programmable calculator.

5. You may use appropriate mathematical instruments.

6. Number the answers correctly according to the numbering system used in this question paper.

7. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.

8. Give brief motivations, discussions, et cetera where required.

9. Round off your final numerical answers to a minimum of TWO decimal places.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The rate of change of velocity (1)

1.2 The distance between two consecutive points in phase on a wave (1)

1.3 A region of space in which an electric charge experiences an electrostatic force (1)

1.4 The type of electromagnetic wave with the shortest wavelength (1)

1.5 The minimum frequency of light needed to remove an electron from the surface of a metal (1)
[5]

QUESTION 2: 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 (2.1–2.10) in the ANSWER BOOK.

2.1 Which ONE of the following physical quantities is equal to the product of force and constant velocity?

A Work

B Power

C Energy

D Acceleration (2)

2.2 A 30 kg iron sphere and a 10 kg aluminium sphere with the same diameter fall freely from the roof of a tall building. Ignore the effects of friction.

When the spheres are 5 m above the ground, they have the same ...

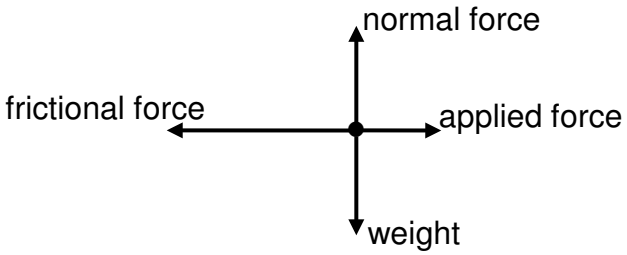
A momentum.

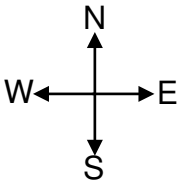
B acceleration.

C kinetic energy.

D potential energy. (2)

2.3 The free-body diagram below shows the relative magnitudes and directions of all the forces acting on an object moving horizontally in an easterly direction.





The kinetic energy of the object ...

A is zero.

B increases.

C decreases.

D remains constant. (2)

2.4 The hooter of a vehicle travelling at constant speed towards a stationary observer, produces sound waves of frequency 400 Hz. Ignore the effects of wind.

Which ONE of the following frequencies, in hertz, is most likely to be heard by the observer?

A 400

B 350

C 380

D 480 (2)

2.5 When two waves meet at a point, the amplitude of the resultant wave is the algebraic sum of the amplitudes of the individual waves.

This principle is known as …

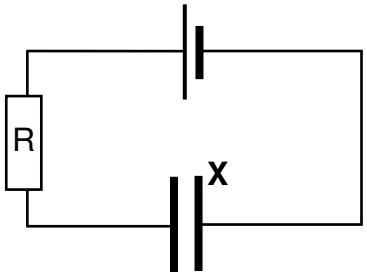
A dispersion.

B the Doppler effect.

C superposition.

D Huygens' principle. (2)

2.6 A parallel plate capacitor, **X**, with a vacuum between its plates is connected in a circuit as shown below. When fully charged, the charge stored on its plates is equal to Q.



Capacitor **X** is now replaced with a similar capacitor, **Y**, with the same dimensions but with paper between its plates. When fully charged, the charge stored on the plates of capacitor **Y** is …

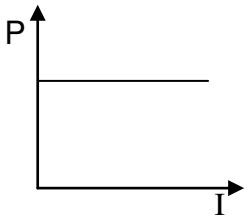
A zero.

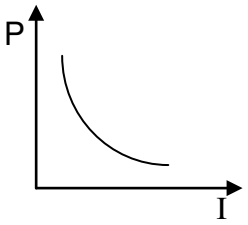
B equal to Q.

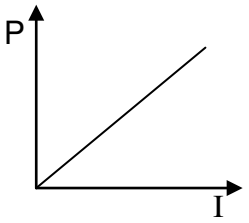
C larger than Q.

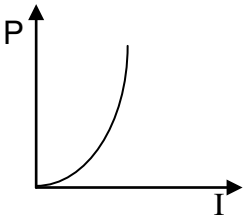
D smaller than Q. (2)

2.7 Which ONE of the following graphs best represents the relationship between the electrical power and the current in a given ohmic conductor?

A


B


C


D


(2)

2.8 In a vacuum, all electromagnetic waves have the same …

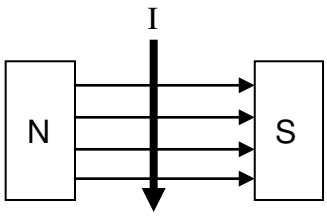
A energy.

B speed.

C frequency.

D wavelength. (2)

2.9 In the sketch below, a conductor carrying conventional current, I, is placed in a magnetic field.



Which ONE of the following best describes the direction of the magnetic force experienced by the conductor?

A Parallel to the direction of the magnetic field

B Opposite to the direction of the magnetic field

C Into the page perpendicular to the direction of the magnetic field

D Out of the page perpendicular to the direction of the magnetic field (2)

2.10 An atom in its ground state absorbs energy *E* and is excited to a higher energy state. When the atom returns to the ground state, a photon with energy ...

A *E* is absorbed.

B *E* is released.

C less than *E* is released.

D less than *E* is absorbed. (2)
[20]

TOTAL SECTION A: 25

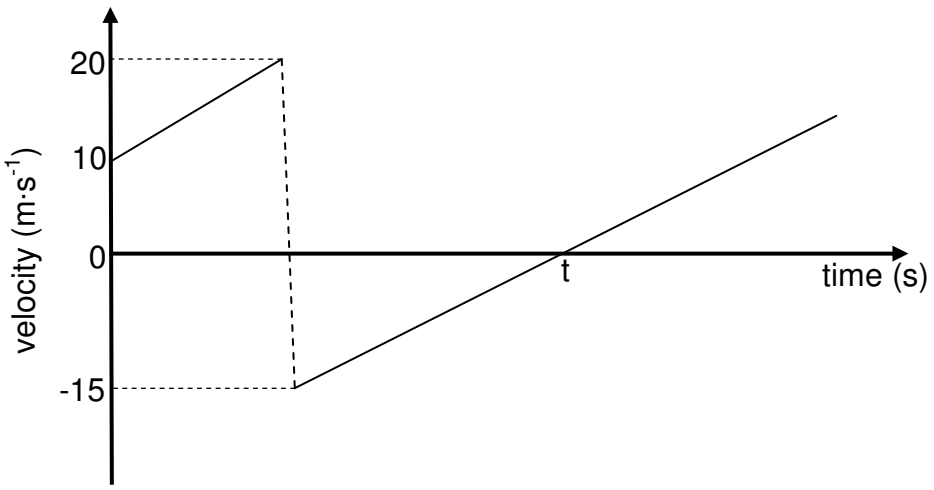
SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A ball of mass 0,15 kg is thrown vertically downwards from the top of a building to a concrete floor below. The ball bounces off the floor. The velocity versus time graph below shows the motion of the ball. Ignore the effects of air friction. TAKE DOWNWARD MOTION AS POSITIVE.



3.1 From the graph, write down the magnitude of the velocity at which the ball bounces off the floor. (1)

3.2 Is the collision of the ball with the floor ELASTIC or INELASTIC? Refer to the data on the graph to explain the answer. (3)

3.3 Calculate the:

3.3.1 Height from which the ball is thrown (4)

3.3.2 Magnitude of the impulse imparted by the floor on the ball (3)

3.3.3 Magnitude of the displacement of the ball from the moment it is thrown until time *t* (4)

3.4 Sketch a position versus time graph for the motion of the ball from the moment it is thrown until it reaches its maximum height after the bounce. USE THE FLOOR AS THE ZERO POSITION.

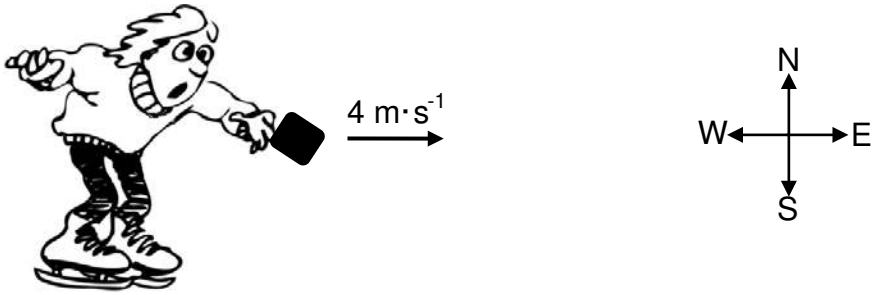
Indicate the following on the graph:

- The height from which the ball is thrown
- Time *t*

(4)
[19]

QUESTION 4 (Start on a new page.)

A boy on ice skates is stationary on a frozen lake (no friction). He throws a package of mass 5 kg at 4 m·s^{-1} horizontally east as shown below. The mass of the boy is 60 kg.



At the instant the package leaves the boy's hand, the boy starts moving.

4.1 In which direction does the boy move? Write down only EAST or WEST. (1)

4.2 Which ONE of Newton's laws of motion explains the direction in which the boy experiences a force when he throws the package? Name and state this law in words. (3)

4.3 Calculate the magnitude of the velocity of the boy immediately after the package leaves his hand. Ignore the effects of friction. (5)

4.4 How will the answer to QUESTION 4.3 be affected if:

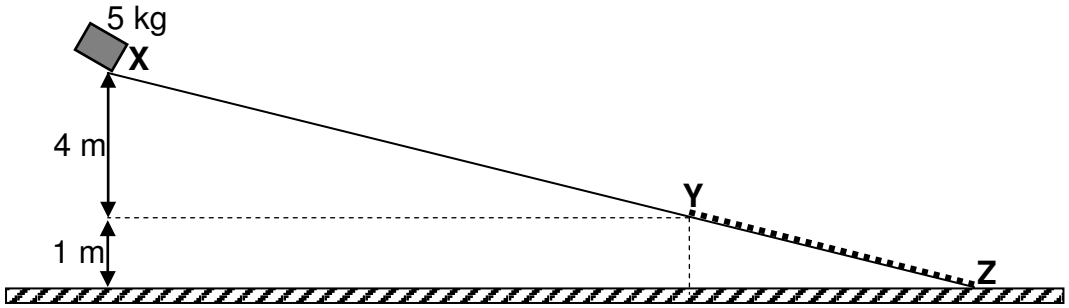
(Write down INCREASES, DECREASES or REMAINS THE SAME.)

4.4.1 The boy throws the same package at a higher velocity in the same direction (1)

4.4.2 The boy throws a package of double the mass at the same velocity as in QUESTION 4.3. Explain the answer. (3)
[13]

QUESTION 5 (Start on a new page.)

A 5 kg rigid crate moves from rest down path **XYZ** as shown below (diagram not drawn to scale). Section **XY** of the path is frictionless. Assume that the crate moves in a straight line down the path.



5.1 State, in words, the *principle of the conservation of mechanical energy*. (2)

5.2 Use the principle of the conservation of mechanical energy to calculate the speed of the crate when it reaches point **Y**. (4)

On reaching point **Y**, the crate continues to move down section **YZ** of the path. It experiences an average frictional force of 10 N and reaches point **Z** at a speed of 4 $m \cdot s^{-1}$.

5.3 APART FROM FRICTION, write down the names of TWO other forces that act on the crate while it moves down section **YZ**. (2)

5.4 In which direction does the net force act on the crate as it moves down section **YZ**? Write down only from '**Y** to **Z**' or from '**Z** to **Y**'. (1)

5.5 Use the WORK-ENERGY THEOREM to calculate the length of section **YZ**. (5)

Another crate of mass 10 kg now moves from point **X** down path **XYZ**.

5.6 How will the velocity of this 10 kg crate at point **Y** compare to that of the 5 kg crate at **Y**? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

[15]

QUESTION 6 (Start on a new page.)

An ambulance approaches a stationary observer at a constant speed of 10,6 $m \cdot s^{-1}$, while its siren produces sound at a constant frequency of 954,3 Hz. The stationary observer measures the frequency of the sound as 985 Hz.

6.1 Name the medical instrument that makes use of the Doppler effect. (1)

6.2 Calculate the velocity of sound. (5)

6.3 How would the wavelength of the sound wave produced by the siren of the ambulance change if the frequency of the wave were higher than 954,3 Hz? Write down only INCREASES, DECREASES or STAYS THE SAME. (1)

6.4 Give a reason for the answer to QUESTION 6.3. (2)
[9]

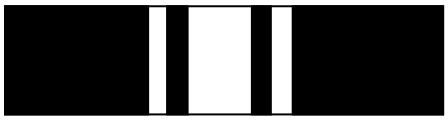
QUESTION 7 (Start on a new page.)

Learners investigate how the broadness of the central bright band in a diffraction pattern changes as the wavelength of light changes. During the investigation, they perform two experiments. The slit width and the distance between the slit and the screen are kept constant.

In the first experiment, they pass light from a monochromatic source through a single slit and obtain pattern **P** on a screen. In the second experiment, they pass light from a different monochromatic source through the single slit and obtain pattern **Q** on the screen.

Pattern P

Pattern Q



7.1 Define the term *diffraction*. (2)

7.2 Which ONE of the two patterns (**P** or **Q**) was obtained using the monochromatic light of a longer wavelength? (1)

7.3 For this investigation, write down the:

7.3.1 Dependent variable (1)

7.3.2 Investigative question (2)

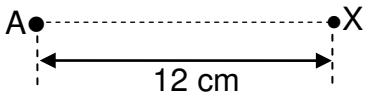
In ONE of their experiments, they use light of wavelength 410 nm and a slit width of 5×10^{-6} m.

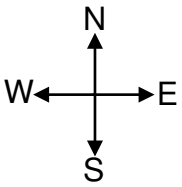
7.4 Calculate the angle at which the SECOND MINIMUM will be observed on the screen. (5)

7.5 The single slit is now replaced with a double slit. Describe the pattern that will be observed on the screen. (2)
[13]

QUESTION 8 (Start on a new page.)

In the diagram below, point charge **A** has a charge of +16 µC. **X** is a point 12 cm from point charge **A**.



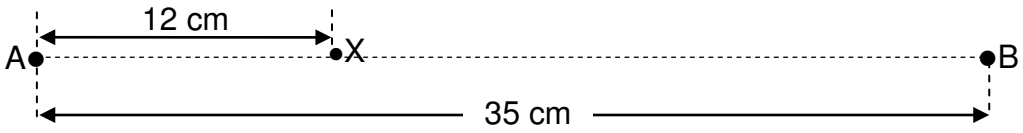


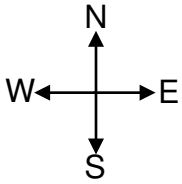
8.1 Draw the electric field pattern produced by point charge **A**. (2)

8.2 Is the electric field in QUESTION 8.1 UNIFORM or NON-UNIFORM? (1)

8.3 Calculate the magnitude and direction of the electric field at point **X** due to point charge **A**. (5)

Another point charge **B** is now placed at a distance of 35 cm from point charge **A** as shown below. The NET electric field at point **X** due to point charges **A** and **B** is 1 x 10^7 $N \cdot C^{-1}$ west.





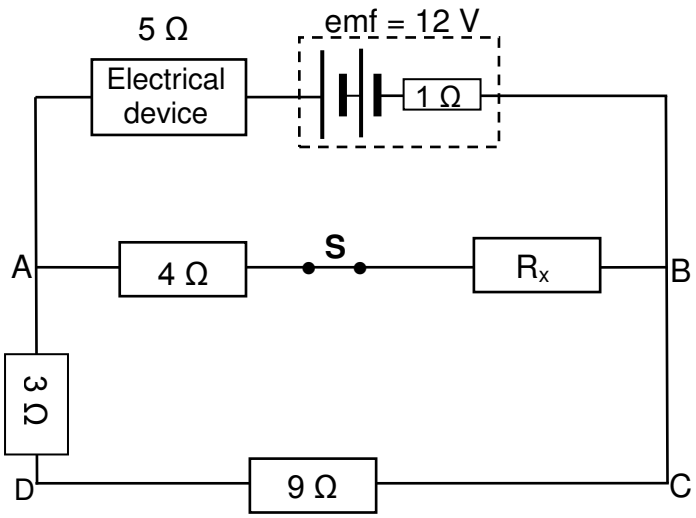
8.4 Is point charge **B** POSITIVE or NEGATIVE? (1)

8.5 Calculate the magnitude of point charge **B**. (5)
[14]

QUESTION 9 (Start on a new page.)

A learner wants to use a 12 V battery with an internal resistance of 1 Ω to operate an electrical device. He uses the circuit below to obtain the desired potential difference for the device to function. The resistance of the device is 5 Ω.

When switch **S** is **closed** as shown, the device functions at its maximum power of 5 W.



9.1 Explain, in words, the meaning of *an emf of 12 V*. (2)

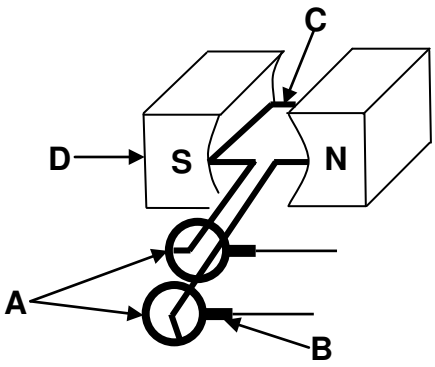
9.2 Calculate the current that passes through the electrical device. (3)

9.3 Calculate the resistance of resistor $\mathbf{R_x}$. (7)

9.4 Switch **S** is now **opened**. Will the device still function at maximum power? Write down YES or NO. Explain the answer without doing any calculations. (4)
[16]

QUESTION 10 (Start on a new page.)

The simplified sketch represents an AC generator. The main components are labelled **A**, **B**, **C** and **D**.



10.1 Write down the name of component:

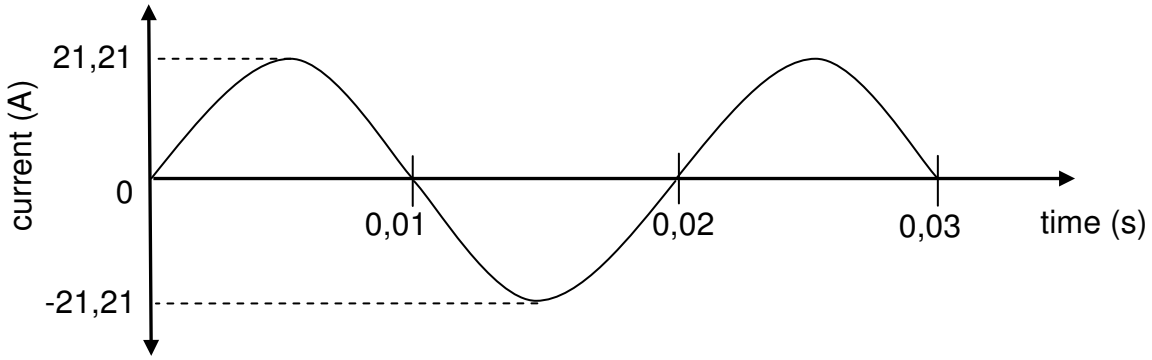
10.1.1 **A** (1)

10.1.2 **B** (1)

10.2 Write down the function of component **B**. (1)

10.3 State the energy conversion which takes place in an AC generator. (1)

A similar coil is rotated in a magnetic field. The graph below shows how the alternating current produced by the AC generator varies with time.



10.4 How many rotations are made by the coil in 0,03 seconds? (1)

10.5 Calculate the frequency of the alternating current. (3)

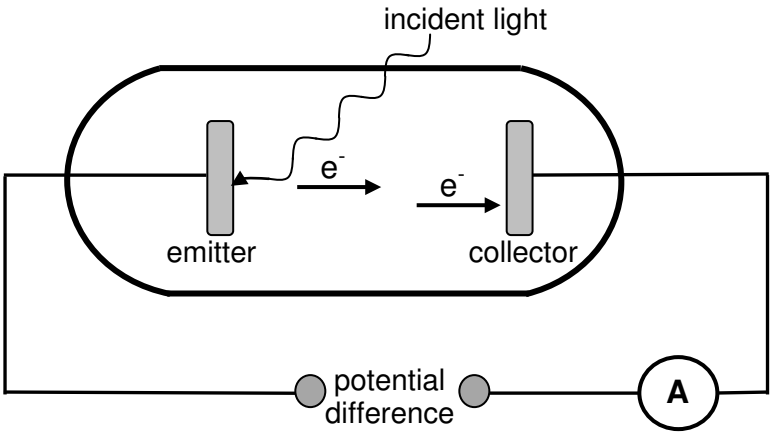
10.6 Will the plane of the coil be PERPENDICULAR TO or PARALLEL TO the magnetic field at t = 0,015 s? (1)

10.7 If the generator produces a maximum potential difference of 311 V, calculate its average power output. (5)

[14]

QUESTION 11 (Start on a new page.)

11.1 In the simplified diagram below, light is incident on the emitter of a photocell. The emitted photoelectrons move towards the collector and the ammeter registers a reading.



11.1.1 Name the phenomenon illustrated above. (1)

11.1.2 The work function of the metal used as emitter is 8,0 x 10^{-19} J. The incident light has a wavelength of 200 nm.

Calculate the maximum speed at which an electron can be emitted. (5)

11.1.3 Incident light of a higher frequency is now used.

How will this change affect the maximum kinetic energy of the electron emitted in QUESTION 11.1.2? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

11.1.4 The intensity of the incident light is now increased.

How will this change affect the speed of the electron calculated in QUESTION 11.1.2? Write down INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

11.2 A metal worker places two iron rods, **A** and **B**, in a furnace. After a while he observes that **A** glows deep red while **B** glows orange.

Which ONE of the rods (**A** or **B**) radiates more energy? Give a reason for the answer. (2)

11.3 Neon signs illuminate many buildings. What type of spectrum is produced by neon signs? (1)
[12]

TOTAL SECTION B: 125
GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}$ $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}$ $J \cdot s$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}$ $N \cdot m^{2} \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}$ C
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}$ kg
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}$ $F \cdot m^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

$v_f = v_i + a\,\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ or/*of* $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\,2} = v_i^{\,2} + 2a\Delta x$ or/*of* $v_f^{\,2} = v_i^{\,2} + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

$W = F\Delta x\cos\theta$	$U = mgh$ or/*of* $E_P = mgh$
$K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$E = \frac{F}{q}$
$U = \frac{kQ_1Q_2}{r}$	$V = \frac{W}{q}$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	emf $(\varepsilon) = I(R + r)$ *emk* $(\varepsilon) = I(R + r)$
$R_s = R_1 + R_2 + \ldots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\,\Delta t$ $W = I^2R\,\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$	/	$I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms}$	/ $P_{gemiddeld} = V_{wgk}I_{wgk}$
			$P_{average} = I_{rms}^2R$	/ $P_{gemiddeld} = I_{wgk}^2R$
$V_{rms} = \frac{V_{max}}{\sqrt{2}}$	/	$V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{average} = \frac{V_{rms}^2}{R}$	/ $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: PHYSICS (P1)
FISIESE WETENSKAPPE: FISIKA (V1)

NOVEMBER 2013

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 16 pages.
Hierdie memorandum bestaan uit 16 bladsye.

SECTION A

QUESTION 1/*VRAAG 1*

1.1 Acceleration / *Versnelling* ✓ (1)

1.2 Wavelength / *Golflengte* ✓ (1)

1.3 Electric field / *Elektriese veld* ✓ (1)

1.4 Gamma / γ (rays) / *Gamma / γ (strale)* ✓ (1)

1.5 Threshold (frequency) / *Drumpel(frekwensie)* ✓ (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 B ✓✓ (2)

2.2 B ✓✓ (2)

2.3 C ✓✓ (2)

2.4 D ✓✓ (2)

2.5 C ✓✓ (2)

2.6 C ✓✓ (2)

2.7 D ✓✓ (2)

2.8 B ✓✓ (2)

2.9 D ✓✓ (2)

2.10 B ✓✓ (2)
[20]

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

SECTION B/*AFDELING B*

QUESTION 3/*VRAAG 3*

3.1 $15\ m\cdot s^{-1}$ ✓ (1)

3.2

OPTION 1/*OPSIE 1*

Inelastic ✓

The speed/velocity at which the ball leaves the floor is less / different than that at which it strikes the floor. OR The speed/velocity of the ball changes during the collision. ✓

Therefore the kinetic energy changes/is not conserved. ✓

Onelasties

Die spoed/snelheid waarteen die bal die vloer verlaat is kleiner / verskillend as dit waarteen dit die vloer tref. OF Die spoed / snelheid van die bal verander gedurende die botsing.

Die kinetiese energie verander/bly nie behoue nie.

OPTION 2/*OPSIE 2*

Collision is inelastic. ✓

Botsing is onelasties

$\Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$= \frac{1}{2}(0,15)(15)^2 - \frac{1}{2}(0,15)(20)^2$ ✓

$= -13,13\ J$

$K_i \neq K_f / \Delta K \neq 0$ ✓

.

OPTION 3/*OPSIE 3*

Collision is inelastic.

Botsing is onelasties. ✓

$K_f = \frac{1}{2}mv_f^2$

$= \frac{1}{2}(0,15)(15)^2$

$= 16,88\ J$

$K_i = \frac{1}{2}mv_i^2$

$= \frac{1}{2}(0,15)(20)^2$ ✓

$= 30\ J$

$K_f \neq K_1 / \Delta K \neq 0$ ✓ (3)

3.3

OPTION 1/*OPSIE 1*

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(20)^2$ ✓ $= (10)^2 + 2(9,8)\Delta y$ ✓

$\therefore \Delta y = 15,31\ m$ ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$ ✓

$F_{net}\Delta y\cos\theta = \frac{1}{2}m(v_f^2 - v_i^2)$

$m(9,8)\Delta y\cos 0°$ ✓ $= \frac{1}{2}m(20^2 - 10^2)$ ✓

$\Delta y = 15,31\ m$ ✓

OPTION 3/*OPSIE 3*

$(E_p + E_k)_{top} = (E_p + E_k)_{bottom}$

$(mgh + \frac{1}{2}mv^2)_{top} = (mgh + \frac{1}{2}mv^2)_{bottom}$ } ✓any one/*enige een*

$m(9,8)h + \frac{1}{2}m(10)^2$ ✓ $= m(9,8)(0) + \frac{1}{2}m(20)^2$ ✓

$h = 15,31\ m$ ✓

OPTION 4/*OPSIE 4*

$v_f = v_i + a\Delta t$

$20 = 10 + (9,8)(\Delta t)$ ✓

$\therefore \Delta t = 1,02\ s$

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

$= (10)(1,02)$ ✓ $+ \frac{1}{2}(9,8)(1,02)^2$ ✓

$\therefore \Delta y = 15,3\ m$ ✓

OPTION 5/*OPSIE 5*

$v_f = v_i + a\Delta t$
$20 = 10 + (9,8)(\Delta t)$ ✓
$\therefore \Delta t = 1,02$ s

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

$\Delta y = \left(\frac{10+20}{2}\right)$ ✓(1,02) ✓
$\therefore \Delta y = 15,3$ m ✓

OPTION 6/*OPSIE 6*

$v_f = v_i + a\Delta t$
$20 = 10 + (9,8)(\Delta t)$ ✓
$\therefore \Delta t = 1,02$ s

Height = area between graph & *t* axis
Hoogte = opperv. tussen grafiek & t-as
= ½(sum ‖ sides)$h_{\perp}$
= ½(10 + 20) ✓1,02 ✓
= 15,3 m✓
= 15,3 m ✓

OPTION 7/*OPSIE 7*

$v_f = v_i + a\Delta t$
$20 = 10 + (9,8)(\Delta t)$ ✓
$\therefore \Delta t = 1,02$ s

Height = area between graph & *t* axis
Hoogte = opperv. tussen grafiek & t-as
= lb + ½bh = ½(10 + 20)1,02
= (1,02)(10) ✓ + ½(1,02)(10) ✓
= 15,3 m ✓

OPTION 8/*OPSIE 8*

$F_{net} = ma$

$mg = m\left(\frac{v_f^2 - v_i^2}{2\Delta x}\right)$ ✓

(0,15)(9,8) ✓ $=(0,15)\left(\frac{20^2 - 10^2}{2\Delta x}\right)$ ✓

$\Delta x = 15,31$ m✓ (4)

3.3.2 $F_{net}\Delta t = \Delta p$
$F_{net}\Delta t = mv_f - mv_i$ } ✓Any one/*Enige een*
$\Delta p = mv_f - mv_i$
= 0,15(-15 – 20) ✓
= - 5,25 N·s (or - 5,25 kg·m·s^{-1})
Magnitude/*Grootte* = 5,25 N·s or 5,25 kg·m·s^{-1}✓ (3)

3.3.3

OPTION 1 / *OPSIE 1*

Displacement from floor to max. height/ *Verplasing van vloer na maks. hoogte*:

$v_f^2 = v_i^2 + 2a\Delta y$ ✓

$(0)^2 = (-15)^2 + 2(9,8)\Delta y$ ✓

$\therefore \Delta y = -11,48$ m

Total displacement / *Totale verplasing*

= - 11,48 + 15,3 ✓

= 3,82 m ✓ / 3,83 m

OPTION 2 / *OPSIE 2*

$v_f = v_i + a\Delta t$

$0 = -15 + (9,8)\Delta t$

$\Delta t = 1,53$ s ✓

$\Delta y = v_i\Delta t + ½ a\Delta t^2$

$= (-15)(1,53) + ½ (9,8)(1,53)^2$ ✓

$= -11,48$ m

Total displacement / *Totale verplasing*

= - 11,48 + 15,3 ✓

= 3,82 m ✓

OPTION 3 / *OPSIE 3*

$v_f = v_i + a\Delta t$

$0 = -15 + (9,8)\Delta t$

$\Delta t = 1,53$ s ✓

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

$= \left(\frac{0 + (-15)}{2}\right)(1,53)$ ✓

$= -11,48$ m

Total displacement / *Totale verplasing*

= - 11,48 + 15,3 ✓

= 3,82 m ✓

OPTION 4 / *OPSIE 4*

$v_f = v_i + a\Delta t$

$0 = -15 + (9,8)\Delta t$

$\Delta t = 1,53$ s ✓

Area = ½ bh

= ½ (1,53)(-15) ✓

= -11,48 m

Total displacement / *Totale verplasing*

= - 11,48 + 15,3 ✓

= 3,82 m ✓

OPTION 5 / *OPSIE 5*

$E_{M(initial)} = E_{M(final)}$
$(E_p + E_k)_{initial} = (E_p + E_k)_{final}$
$(mgh + ½ mv^2)_{initial} = (mgh + ½ mv^2)_{final}$ ✓Any one /*Enige een*

$\underline{(0,15)(9,8)(0) + ½ (0,15)(15)^2} = \underline{(0,15)(9,8)h + ½ (0,15)(0)^2}$ ✓
h = 11,48 m

Total displacement / *Totale verplasing*
= 15,31 - 11,48 ✓ = 3,83 m ✓

OPTION 6/*OPSIE 6*

$W_{net} = \Delta K$ ✓
$F_{net}\Delta y\cos\theta = ½ m(v_f^2 - v_i^2)$
$\underline{m(9,8)\Delta y\cos 180°} = ½ m(\underline{0^2} - \underline{15^2})$ ✓
Δy = 11,48 m

Total displacement / *Totale verplasing*
= 15,31 - 11,48 ✓
= 3,83 m ✓

OPTION 7/*OPSIE 7*

$F_{net} = ma$

$mg = m\left(\frac{v_f^2 - v_i^2}{2\Delta x}\right)$ ✓

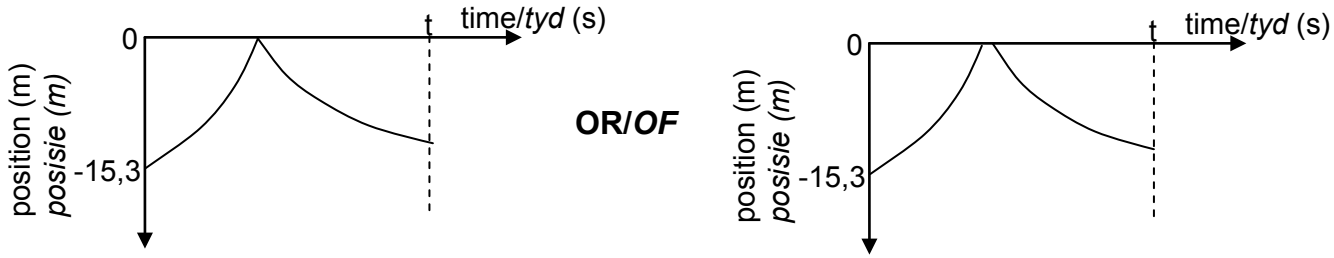
$(0,15)(9,8) = (0,15)\left(\frac{0^2 - (-15)^2}{2\Delta x}\right)$ ✓

Δx = -11,48 m

Total displacement / *Totale verplasing*
= 15,31 - 11,48 ✓
= 3,83 m ✓

(4)

3.4



Marking criteria for graph:/*Nasienriglyne vir grafiek:*	
Correct shape as shown for first part./*Korrekte vorm soos aangetoon vir eerste deel.*	✓
Correct shape as shown for the second part up to t / 2,55 s. *Korrekte vorm soos aangetoon vir tweede deel t / 2,55 s.*	✓
Graph starts at -15,3 m at t = 0 s./*Grafiek begin by -15,3 m by t = 0 s.*	✓
Maximum height after bounce at time *t* / 2,55 s./*Maksimum hoogte na bons by tyd t./ 2,55 s.* Maximum height after bounce less than 15,3 m./*Maksimum hoogte na bons kleiner as 15,3 m.*	✓

(4)
[19]

QUESTION 4/*VRAAG 4*

4.1 West / *Wes* ✓ (1)

4.2 (Newton's) Third Law (of Motion) ✓
When object A exerts a force on object B,
object B exerts a force equal in magnitude on object A✓, but opposite in direction. ✓

(Newton) se Derde (Bewegings)wet
Wanneer voorwerp A 'n krag op voorwerp B uitoefen,
oefen voorwerp B 'n krag van gelyke grootte op voorwerp A, maar in die teenoorgestelde rigting. (3)

4.3

OPTION 1/ *OPSIE 1* **East as positive/Oos *as positief:*** $\Sigma p_i = \Sigma p_f$ ✓ 0 ✓ $= (60)v_f + (5)(4)$ ✓ $\therefore v_f = -0,33$✓ $\therefore v_f = 0,33\ m\cdot s^{-1}$✓	**OPTION 2/*OPSIE 2*** **East as positive/*Oos as positief:*** $\Delta p_A = -\Delta p_B$ ✓ $(60)v_f$ ✓$- 0 = -[(5)(4) - 0]$ ✓ $\therefore v_f = -0,33$ ✓ $\therefore v_f = 0,33\ m\cdot s^{-1}$✓
West as positive/*Wes as positief:* $\Sigma p_i = \Sigma p_f$ ✓ 0 ✓ $= (60)v_f + (5)(-4)$ ✓ $\therefore v_f = 0,33\ m\cdot s^{-1}$✓✓	**West as positive/*Wes as positief:*** $\Delta p_A = -\Delta p_B$ ✓ $(60)v_f$ ✓$- 0 = -[(5)(-4) - 0]$ ✓ $\therefore v_f = 0,33\ m\cdot s^{-1}$✓✓
OPTION 3/ *OPSIE 3* **East as positive/Oos *as positief*** $F_{BP} = -F_{PB}$✓ $m_Ba_B = -m_Pa_P$ $m_B\left(\frac{v_{Bf}-v_{Bi}}{\Delta t}\right) = -m_P\left(\frac{v_{Pf}-v_{Pi}}{\Delta t}\right)$ $(60)\left(\frac{v_{Bf}-0}{\Delta t}\right)$✓$= -(5)\left(\frac{4-0}{\Delta t}\right)$✓ $v_{Bi} = -0,33\ m\cdot s^{-1}$✓ $= 0,33\ m\cdot s^{-1}$✓	**OPTION 4/ *OPSIE 4*** **West as positive/*Wes as positief*** $F_{BP} = -F_{PB}$✓ $m_Ba_B = -m_Pa_P$ $m_B\left(\frac{v_{Bf}-v_{Bi}}{\Delta t}\right) = -m_P\left(\frac{v_{Pf}-v_{Pi}}{\Delta t}\right)$ $(60)\left(\frac{v_{Bf}-0}{\Delta t}\right)$✓$= -(5)\left(\frac{-4-0}{\Delta t}\right)$✓ $v_{Bi} = 0,33\ m\cdot s^{-1}$✓✓

(5)

4.4
4.4.1 Increases / *Verhoog* ✓ (1)

4.4.2 Increases / *Verhoog* ✓

- ∆p package increases, thus ∆p boy increases. ✓
  ∆p pakkie vermeerder, dus ∆p seun vermeerder.
- For the same mass of boy, v will be greater. ✓
  Vir dieselfde massa van die seun sal v groter wees.

OR/*OF*

Increases / *Verhoog*✓

From the equation in QUESTION 4.3: $-m_Av_{Af} = m_Bv_{Bf}$

Vanaf die vegelyking in VRAAG 4.3: $-m_Av_{Af} = m_Bv_{Bf}$

- If mass of package/B doubles/increases, the momentum of the boy / A doubles / increases.✓
  Indien die massa van pakkie / B verdubbel / toeneem, verdubbel / vermeerder die momentum van die seun / A
- For same mass of boy / A, the velocity of boy / A doubles/increases.✓
  Vir dieselfde massa van die seun / A, verdubbel/vermeerder die snelheid van die seun /A.

OR/*OF*

Increases / *Verhoog* ✓

$-m_Bv_{Bf} = m_pv_{pf}$

$v_B = \frac{-m_pv_{pf}}{m_B}$ ✓ for same m_B, if m_P doubles, ✓ then v_B doubles

(3)
[13]

QUESTION 5/*VRAAG 5*

5.1 The total mechanical energy remains constant / is conserved ✓
in a closed / isolated system / in absence of external forces /non-conservative forces. ✓
Die totale meganiese energie in bly konstant / bly behoue
in 'n geslote / geïsoleerde sisteem /in afwesigheid van eksterne kragte /nie-konserwatiewe kragte.

OR/*OF*

The sum of the potential and kinetic energy of a system remains constant ✓
in a closed/isolated system. ✓
Die som van die potensiële en kinetiese energie van *'n sisteem bly konstant*
in 'n geslote / geïsoleerde sisteem.

OR/*OF*

When the work done on an object by the non-conservative forces is zero✓,
the total mechanical energy is conserved. ✓
Wanneer die arbeid deur die nie-konserwatiewe kragte op 'n voorwerp verrig nul is, bly die totale meganiese energie behoue.

(2)

5.2

OPTION 1/*OPSIE 1*

$E_{mechanical\ at\ X} = E_{mechanical\ at\ Y}$
$(E_p + E_k)_X = (E_p + E_k)_Y$
$(mgh + ½\ mv^2)_X = (mgh + ½\ mv^2)_Y$
✓Any one/*Enige een*

$\underline{5(9,8)(5)} + ½(5)(0^2)$✓$= \underline{(5)(9,8)(1)} + ½(5)v_f^2$ ✓
$v = 8,85\ m\cdot s^{-1}$ ✓

OPTION 2/*OPSIE 2*

$E_{mechanical\ at\ X} = E_{mechanical\ at\ Y}$
$(E_p + E_k)_X = (E_p + E_k)_Y$
$(mgh + ½\ mv^2)_X = (mgh + ½\ mv^2)_Y$
✓ Any one/*Enige een*

$\underline{5(9,8)(4)} + ½(5)(0^2)$✓$= \underline{(5)(9,8)(0)} + ½(5)v_f^2$ ✓
$v = 8,85\ m\cdot s^{-1}$ ✓

(4)

5.3 Weight / gravitational (force) / (force of) gravity ✓
Gewig / Gravitasie(krag)
Normal force / *Normaalkrag* ✓ (2)

5.4 Z to/*na* Y ✓ (1)

5.5

OPTION 1/*OPSIE 1*

$W_{net} = \Delta K$ ✓
$W_w + W_f = ½m(v_f^2 - v_i^2)$
$mg\Delta y\cos 0° + f\Delta x\cos 180° = ½\ m(v_f^2 - v_i^2)$
$(5)(9,8)(1)(1)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 - 8,85^2)$ ✓
$\Delta x = 20,48$ m ✓

OPTION 2/*OPSIE 2*

$W_{net} = \Delta K$ ✓
$W_w + W_f = ½m(v_f^2 - v_i^2)$
$-\Delta E_p + W_f = ½m(v_f^2 - v_i^2)$
$-(0 - mgh) + f\Delta x\cos 180° = ½\ m(v_f^2 - v_i^2)$
$(5)(9,8)(1)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 - 8,85^2)$ ✓
$\Delta x = 20,48$ m ✓

OPTION 3/*OPSIE 3*

$W_{net} = \Delta K$ ✓
$W_w + W_f = ½m(v_f^2 - v_i^2)$
$-\Delta E_p + W_f = ½m(v_f^2 - v_i^2)$
$-(0 - mgh) + f\Delta x\cos 180° = ½\ m(v_f^2 - v_i^2)$
$(5)(9,8)(5)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 - 0^2)$ ✓
$\Delta x = 20,48$ m ✓

OPTION 4/*OPSIE 4*

$W_{net} = \Delta K$ ✓
$W_w + W_f = ½m(v_f^2 - v_i^2)$
$mg\Delta x\cos(90^o - \theta) + f\Delta x\cos 180° = ½\ m(v_f^2 - v_i^2)$
$mg\Delta x\sin\theta + f\Delta x\cos 180° = ½\ m(v_f^2 - v_i^2)$
$mg\Delta x\left(\frac{1}{\Delta x}\right) + f\Delta x\cos 180° = ½\ m(v_f^2 - v_i^2)$
$(5)(9,8)$ ✓ $+ (10)\Delta x(-1)$ ✓ $= ½(5)(4^2 - 8,85^2)$ ✓
$\Delta x = 20,48$ m ✓

OPTION 5/*OPSIE 5*

$W_{net} = \Delta K$ ✓
$W_{w||} + W_f = ½m(v_f^2 - v_i^2)$
$mgsin\theta\Delta xcos\theta + f\Delta xcos\theta = ½ m(v_f^2 - v_i^2)$
$mg\left(\frac{1}{\Delta x}\right)\Delta xcos0° + f\Delta xcos180° = ½ m(v_f^2 - v_i^2)$
(5)(9,8) ✓ + (10)Δx(-1) ✓ = ½(5)($4^2 - 8,85^2$) ✓
Δx = 20,48 m ✓

OPTION 6/*OPSIE 6*

$W_{net} = \Delta K$ ✓
$F_{net}\Delta xcos\theta = ½m(v_f^2 - v_i^2)$
$(10 - 49sin\theta)\Delta xcos180° = ½ m(v_f^2 - v_i^2)$
$(10 - 49\left(\frac{1}{\Delta x}\right)$)✓$\Delta xcos180° = ½ m(v_f^2 - v_i^2)$
(10Δx – 49)(-1)✓ = ½(5)($4^2 - 8,85^2$) ✓
Δx = 20,48 m

OPTION 7/*OPSIE 7*

$W_{nc} = \Delta E_p + \Delta E_k$✓
$f\Delta xcos\theta = (mgh_f - mgh_i) + (½ mv_f^2 - ½ mv_i^2)$
(10)Δxcos180° ✓= [0 – (5)(9,8)(1)] ✓ + [½ (5)$(4)^4$ – ½ (5)$(8,85)^2$✓
Δx = 20,48 m✓ (5)

5.6 Equal to / *Gelyk aan* ✓ (1)
[15]

QUESTION 6/*VRAAG 6*

6.1 Doppler flow meter / *Dopplervloeimeter* ✓ (1)

6.2 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

985 ✓ = $\frac{v}{(v - 10,6)}$ ✓(954,3) ✓
v = 340,1 m·s^{-1} ✓ (5)

6.3 Decreases / *Afneem* ✓ (1)

6.4 For a constant velocity of sound / speed ✓
if the frequency increases, λ decreases. ✓
Vir 'n konstante snelheid van klank /spoed,
as die frekwensie toeneem neem λ af.

OR/*OF*

$\lambda \alpha \frac{1}{f}$ or $f \alpha \frac{1}{\lambda}$ ✓ at constant velocity/speed / *by konstante snelheid/spoed..* ✓ (2)
[9]

QUESTION 7/*VRAAG 7*

7.1 The bending of waves around obstacles / corners / through an opening / aperture ✓✓
Die buiging van golwe om versperrings / hoeke / deur 'n opening.

OR/*OF*
The spreading of waves around the edge of a barrier/through an opening/aperture.
Die uitspreiding van golwe om die kant van 'n versperring/deur 'n opening. (2)

7.2 P ✓ (1)

7.3

7.3.1 Broadness of the central bright band / diffraction pattern / angle of diffraction / degree of diffraction / sin θ / position of the first minimum ✓
Breedte van die sentrale helderband / diffraksiepatroon/hoek van diffraksie / mate van diffraksie / sin θ / posisie van die eerste minimum (1)

7.3.2

Criteria for investigative question/*Kriteria vir ondersoekende vraag*:	
Dependent and independent variables correctly identified. *Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.*	✓
Question about the relationship between the independent and dependent variables correctly formulated. Vraag oor die verwantskap tussen die *afhanklike en onafhanklike veranderlikes korrek geformuleer.*	✓

Example/*Voorbeeld*:
What is the relationship between the broadness of the central band and the wavelength (of light used)?
Wat is die verwantskap tussen die breedte van die sentrale band en die golflengte (van die lig)? (2)

7.4

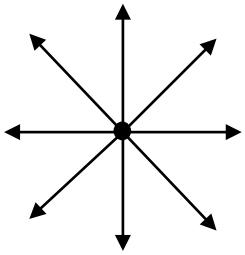
OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\sin\theta = \frac{m\lambda}{a}$ ✓ $\sin\theta = \frac{(2)(410\times10^{-9})}{5\times10^{-6}}$ ✓ ✓ ✓ $\therefore\theta = 9{,}44°$ ✓ or $9{,}21°$	$\sin\theta = \frac{m\lambda}{a}$ ✓ $\sin\theta = \frac{(-2)(410\times10^{-9})}{5\times10^{-6}}$ ✓ ✓ ✓ $\therefore\theta = -9{,}44°$ ✓ or $-9{,}21°$

(5)

7.5 Light (bright) and dark bands.✓
Light /dark bands of equal width. ✓
Lig (helder) en donker bande eweredig gespasieer.
Helder / donker bande van gelyke breedte /wydte. (2)
[13]

QUESTION 8/*VRAAG 8*

8.1



Criteria for sketch:/*Kriteria vir skets:*	
Correct shape - field lines radially around charge. *Korrekte vorm – veldlyne radiaal uitwaarts.*	✓
Direction of field lines away from charge. *Rigting van veldlyne weg van lading af.*	✓

(2)

8.2 Non-uniform / *Nie-uniform* ✓ (1)

8.3
$$E = \frac{kQ}{r^2} \checkmark$$
$$= \frac{(9\times10^{9})(16\times10^{-6})}{(0,12)^2} \checkmark$$
$$= 1 \times 10^{7}\ N\cdot C^{-1} \checkmark \text{ east/}oos \checkmark$$ (5)

8.4 Positive / *Positief* ✓ (1)

8.5

West: positive	**West: negative**
$E_A + E_B = E_{net}$	$E_A + E_B = E_{net}$
$-1 \times 10^{7} + E_B$ ✓$= 1 \times 10^{7}$✓	$1 \times 10^{7} + E_B$ ✓$= -1 \times 10^{7}$✓
$\therefore E_B = 2 \times 10^{7}\ N\cdot C^{-1}$	$\therefore E_B = -2 \times 10^{7}\ N\cdot C^{-1}$ $= 2 \times 10^{7}\ N\cdot C^{-1}$
$E_B = \frac{kQ_B}{r^2}$	$E_B = \frac{kQ_B}{r^2}$
$\therefore 2 \times 10^{7}$ ✓$= \frac{(9\times10^{9})Q_B}{(0,23)^2}$ ✓	$\therefore 2 \times 10^{7}$ ✓$= \frac{(9\times10^{9})Q_B}{(0,23)^2}$ ✓
$\therefore Q_B = 1,18\times10^{-4}$ C ✓	$\therefore Q_B = 1,18\times10^{-4}$ C ✓
(5)	(5)

(5)
[14]

QUESTION 9/*VRAAG 9*

9.1 12 J of energy are transferred to / work done on ✓
each coulomb (of charge) / per C charge ✓ passing through the battery.

12 J energie word oorgedra aan / arbeid word verrig op
elke coulomb (lading) / per C lading wat deur die battery beweeg. (2)

9.2

OPTION 1/*OPSIE 1*

$P = I^2R$ ✓
$5 = I^2(5)$ ✓
$\therefore I = 1$ A ✓

OPTION 2/*OPSIE 2*

$P = \frac{V^2}{R}$
$5 = \frac{V^2}{5}$ ✓
$V = 5$ V

$P = VI$
$5 = (5)I$ ✓
$I = 1$ A✓

OPTION 3/*OPSIE 3*

$P = \frac{V^2}{R}$
$5 = \frac{V^2}{5}$ ✓
$V = 5$ V

$V = IR$
$5 = I(5)$ ✓
$I = 1$ A✓

(3)

9.3

OPTION 1 / *OPSIE 1*

Emf = $I(R + r)$ ✓
12 ✓= (1)(R + 1)
R = 11 Ω

R_p = 11 – 5✓ = 6 Ω

OPTION 2 / *OPSIE 2*

Emf = $I(R + r)$ ✓
12 ✓= (1)(R_p + 5 + 1)✓
$\therefore R_p = 6$ Ω

OPTION 3/OPSIE 3

$V = I R_T$ ✓
12✓ = (1)R
R_T = 12 Ω

$R_p = R_T – (5 + 1)$
= 12 – 6 ✓
= 6 Ω

$\frac{1}{R_p} = \frac{1}{R_{12}} + \frac{1}{R}$ ∴ $\frac{1}{6}$✓$= \frac{1}{12}$✓$+ \frac{1}{4+R_X}$✓∴ $\frac{1}{12} = \frac{1}{4+R_X}$ ∴ 12 = 4 + R_x ∴R_x = 8 Ω✓

OR/*OF*

$R_p = \frac{(4+R_X)(12)}{4+R_X+12}$ ∴ $R_p = \frac{(4+R_X)(12)}{4+R_X+12}$ ∴ 6✓$= \frac{(4+R_X)(12)}{4+R_X+12}$ ∴ R_x = 8 Ω ✓

OPTION 4/*OPSIE 4*

$V_{5Ω} = IR$ ✓
= (1)(5)
= 5 V

$V_{internal} = Ir$
= (1)(1)
= 1 V

$V_{parallel}$ = 12✓– (1 + 5) ✓
= 6 V

$V_{parallel} = IR$
6 = I(12) ✓
∴I = 0,5 A

I_{Rx} = 1 – 0,5
= 0,5 A

V = IR
6✓ = (0,5)(4 + R_x) ✓
∴R_x = 8 Ω ✓

(7)

9.4 

No / *Nee* ✓

Total resistance (R) increases. / *Totale weerstand (R) neem toe*.✓
Current (I) decreases / *Stroom (I) neem af.* ✓
(For a constant R) power ($P = I^2R$) decreases.✓
(Vir konstante R) drywing ($P = I^2R$) verminder. (4)

[16]

QUESTION 10/*VRAAG 10*

10.1
10.1.1 slip rings / *sleepringe* ✓ (1)

10.1.2 brush(es) / *borsel(s)* ✓ (1)

10.2 Maintains electrical contact with the slip rings.
Handhaaf elektriese kontak met die sleepringe.

OR/*OF*
To take current out/in of the coil.
Om die stroom uit/in die spoel te neem. (1)

10.3 Mechanical /kinetic energy to electrical energy. ✓
Meganiese / kinetiese energie na elektriese energie. (1)

10.4 1½ ✓ (1)

10.5

OPTION 1/ *OPSIE 1*

$f = \frac{1}{T}$ ✓

$= \frac{1}{0,02}$ ✓

$= 50$ Hz ✓

(3)

OPTION 2/ *OPSIE 2*

$f = \frac{\text{number of cycles}}{\text{time}}$ ✓

$= \frac{1,5}{0,03}$ or/of $\frac{1}{0,02}$ or/of $\frac{0,5}{0,01}$ ✓

$= 50$ Hz ✓

(3)

(3)

10.6 Parallel to / *Parallel aan* ✓ (1)

10.7

OPTION 1/ *OPSIE 1*

$P_{ave} = V_{rms}I_{rms}$ ✓

$= \left(\frac{V_{max}}{\sqrt{2}}\right)\left(\frac{I_{max}}{\sqrt{2}}\right)$ ✓ (1 mark for both formulae / *1 punt vir beide formules*)

$= \left(\frac{311}{\sqrt{2}}\right)$✓$\left(\frac{21{,}21}{\sqrt{2}}\right)$ ✓

= 3 298,16 W ✓ (Accept range / *Aanvaar gebied*: 3298,13 – 3299,18 W)

OPTION 2/ *OPSIE 2*

$P_{ave} = \frac{V_{max}I_{max}}{2}$ ✓✓

$= \frac{(311)(21.21)}{2}$ ✓✓

= 3298,16 W✓

OPTION 3 / *OPSIE 3*

$V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{311}{\sqrt{2}}$ ✓✓= 219,91 V

$I_{rms} = \frac{I_{max}}{\sqrt{2}} = \frac{21{,}21}{\sqrt{2}}$ ✓= 14,998 A

$P_{ave} = V_{rms}I_{rms}$ ✓

= (219,91)(14,998)

= 3 298,21 W ✓

OPTION 4/ *OPSIE 4*

$R = \frac{V_{max}}{I_{max}}$

$= \frac{311}{21{,}21}$ ✓

= 14,66 Ω

$V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{311}{\sqrt{2}}$ ✓= 219,91 V

$P_{ave} = \frac{V_{rms}^2}{R}$ ✓

$= \frac{(219{,}91)^2}{14{,}66}$ ✓

= 3 298,8 W✓

OPTION 6/*OPSIE 6*

$R = \frac{V_{max}}{I_{max}}$

$= \frac{311}{21{,}21}$ ✓

= 14,66 Ω

$I_{rms} = \frac{I_{max}}{\sqrt{2}} = \frac{21{,}21}{\sqrt{2}}$ ✓= 14,998 A

$P_{ave} = I_{rms}^2R$ ✓

$= (14{,}998)^2(14{,}66)$ ✓

= 3 297,62 W✓

(5)
[14]

QUESTION 11/*VRAAG 11*

11.1

11.1.1 Photo-electric effect / *Foto-elektriese effek* ✓ (1)

11.1.2

OPTION 1/*OPSIE 1*

$E = W_0 + E_k$

$hf = hf_0 + E_k$

$\frac{hc}{\lambda} = W_0 + ½mv^2$

✓ Any one/*Enige een*

$\frac{(6,63 \times 10^{-34})(3x10^8)}{200 \times 10^{-9}}$ ✓ = 8 x 10^{-19} ✓ + ½(9,11 x 10^{-31})v^2 ✓

v= 6,53 x 10^5 m·s^{-1} ✓ (653454,89 m·s^{-1})

OPTION 2 / *OPSIE 2*

c = fλ
3 x 10^8 = f(200 x 10^{-9})
f = 1,5 x 10^{15} Hz

$hf = hf_0 + E_k$✓

(6,63 x 10^{-34})(1,5 x 10^{15}) ✓= 8 x 10^{-19} ✓ + ½(9,11 x 10^{-31})v^2 ✓

v= 6,53 x 10^5 m·s^{-1} ✓ (5)

11.1.3 Increases / *Vermeerder* ✓ (1)

11.1.4 Remains the same / *Bly dieselfde* ✓
Intensity only affects number of photoelectrons emitted per second. ✓
Intensiteit beïnvloed slegs die getal foto-elektrone vrygestel per sekonde.

OR/*OF*

Remains the same / *Bly dieselfde* ✓
The kinetic energy of the emitted photoelectrons remains the same.
Die kinetiese energie van die vrygestelde foto-elektrone bly dieselfde.

OR/*OF*

Remains the same / *Bly dieselfde* ✓
Only the frequency/wavelength of the incident light affects the maximum kinetic energy.
Slegs the frekwensie/golflengte van die invallende lig beïnvloed die maksimum kinetiese energie. (2)

11.2 B ✓
Orange light has a higher frequency than red light. ✓
Oranje lig het 'n hoër frekwensie as rooi lig.

OR/*OF*

Orange light has smaller wavelength than red light.
Oranje lig het 'n kleiner golflengte as rooi lig. (2)

11.3 Line emission (spectra) / *Lyn emissie(spektrum)* ✓ (1)

[12]

TOTAL SECTION B/*TOTAAL AFDELING B*: 125
GRAND TOTAL/*GROOTTOTAAL*: 150

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2013

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2. Answer ALL the questions in the ANSWER BOOK.

3. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

4. You may use a non-programmable calculator.

5. You may use appropriate mathematical instruments.

6. Number the answers correctly according to the numbering system used in this question paper.

7. Data sheets and a periodic table are attached for your use.

8. Give brief motivations, discussions, et cetera where required.

9. Round off your final numerical answers to a minimum of TWO decimal places.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The industrial preparation of nitrogen gas from liquid air (1)

1.2 The removal of water from a compound during a reaction (1)

1.3 A theory used to explain how factors, such as temperature, change the rate of a reaction (1)

1.4 The general term used to describe a substance that donates electrons to another substance (1)

1.5 The general term used to describe a class of organic compounds in which one member differs from the previous one by a CH_2 group (1)
[5]

QUESTION 2: 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 (2.1–2.10) in the ANSWER BOOK.

2.1 Which ONE of the following is the functional group of aldehydes?

A ─ COO ─

B ─ COOH

C ─ CHO

D ─ OH (2)

2.2 Which ONE of the following hydrocarbons always gives a product with the same IUPAC name when ANY ONE of its hydrogen atoms is replaced with a chlorine atom?

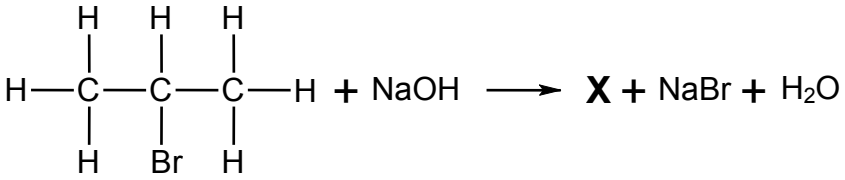
A Hexane

B Hex-1-ene

C Cyclohexane

D Cyclohexene (2)

2.3 The equation below represents the reaction that takes place when an organic compound and concentrated sodium hydroxide are strongly heated. **X** represents the major organic product formed.



Which ONE of the following is the correct IUPAC name for compound **X**?

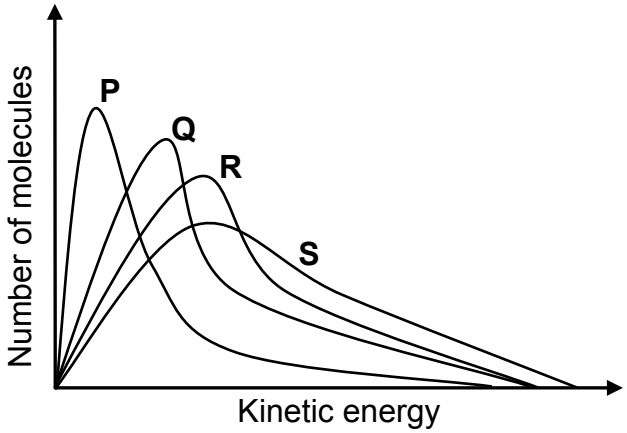
A Prop-1-ene

B Prop-2-ene

C Propan-1-ol

D Propan-2-ol (2)

2.4 The graphs below represent the molecular distribution for a reaction at different temperatures.



Which ONE of the graphs above represents the reaction at the highest temperature?

A P

B Q

C R

D S (2)

2.5 The reaction represented below reaches equilibrium in a closed container.

$$CuO(s) + H_2(g) \rightleftharpoons Cu(s) + H_2O(g) \quad \Delta H < 0$$

Which ONE of the following changes will increase the yield of products?

A Increase temperature.

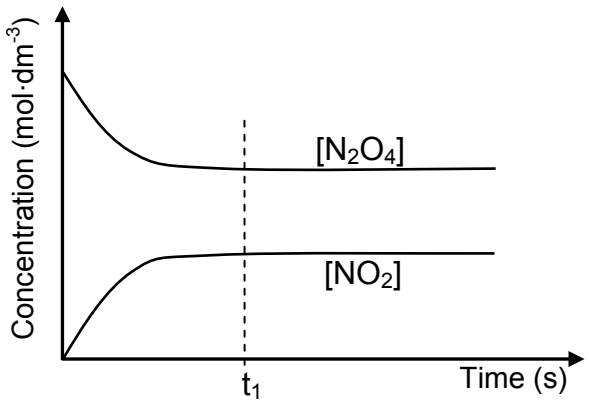
B Decrease temperature.

C Increase pressure by decreasing the volume.

D Decrease pressure by increasing the volume. (2)

2.6 The graph below represents the decomposition of $N_2O_4(g)$ in a closed container according to the following equation:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$



Which ONE of the following correctly describes the situation at t_1?

A The N_2O_4 gas is used up.

B The NO_2 gas is used up.

C The rate of the forward reaction equals the rate of the reverse reaction.

D The concentrations of the reactant and the product are equal. (2)

2.7 Which ONE of the following is the strongest oxidising agent?

A $F_2(g)$

B $F^-(aq)$

C $Li(s)$

D $Li^+(aq)$ (2)

2.8 Which ONE of the following statements about a galvanic cell in operation is CORRECT?

A ΔH for the cell reaction is positive.

B The overall cell reaction is non-spontaneous.

C The emf is negative.

D ΔH for the cell reaction is negative. (2)

2.9 The function of the salt bridge in a galvanic cell in operation is to ...

A allow anions to travel to the cathode.

B maintain electrical neutrality in the half-cells.

C allow electrons to flow through it.

D provide ions to react at the anode and cathode. (2)

2.10 The major product formed at the ANODE in a membrane cell is ...

A hydrogen.

B oxygen.

C chlorine.

D hydroxide ions. (2)
[20]

TOTAL SECTION A: 25

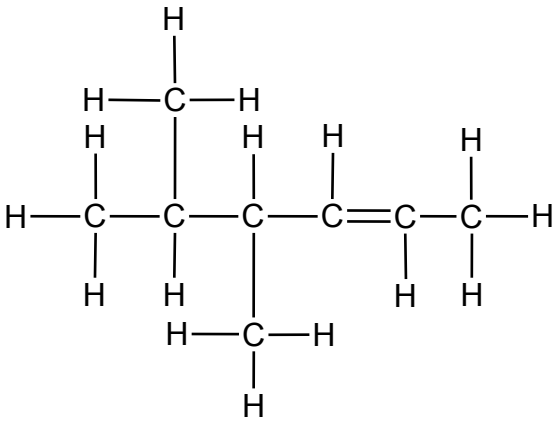
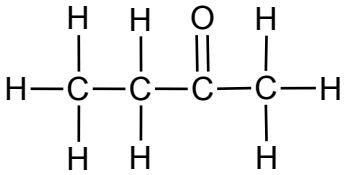
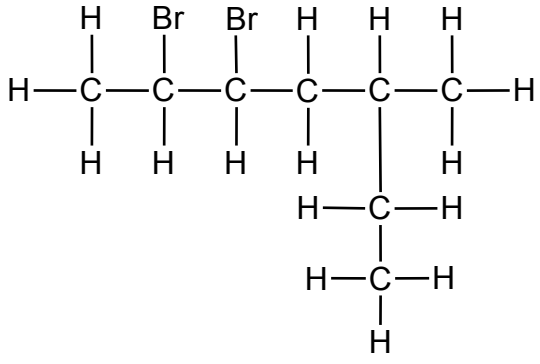
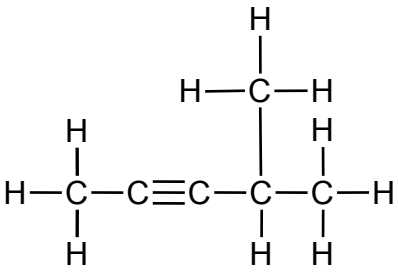
SECTION B

INSTRUCTIONS

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A		**B**	
C	$CH_3CH{=}CHCH_2CH_2CH_3$	**D**	Pentyl propanoate
E		**F**	

3.1 Write down the letter(s) that represent(s) the following:

3.1.1 Alkenes (2)

3.1.2 A ketone (1)

3.1.3 A compound with the general formula C_nH_{2n-2} (1)

3.1.4 A structural isomer of cyclohexene (2)

3.2 Write down the IUPAC name of compound:

3.2.1 **A** (2)

3.2.2 **E** (2)

3.2.3 **F** (2)

3.3 Compound **D** is prepared by reacting two organic compounds in the presence of an acid as catalyst.

Write down the:

3.3.1 Homologous series to which compound **D** belongs (1)

3.3.2 Structural formula of compound **D** (2)

3.3.3 IUPAC name of the organic acid used to prepare compound **D** (1)

3.3.4 NAME or FORMULA of the catalyst used (1)
[17]

QUESTION 4 (Start on a new page.)

A laboratory technician is supplied with three unlabelled bottles containing an alcohol, an aldehyde and an alkane respectively of comparable molecular mass. She takes a sample from each bottle and labels them **P**, **Q** and **R**.

In order to identify each sample, she determines the boiling point of each under the same conditions. The results are shown in the table below.

SAMPLE	BOILING POINT (°C)
P	76
Q	36
R	118

4.1 For this investigation, write down the:

4.1.1 Independent variable (1)

4.1.2 Dependent variable (1)

4.2 From the passage above, write down a phrase that shows that this investigation is a fair test. (1)

4.3 Which sample (**P**, **Q** or **R**) is the:

4.3.1 Alkane (1)

4.3.2 Alcohol (1)

4.3.3 Refer to boiling point and the type of intermolecular forces present between alcohol molecules to give a reason for the answer in QUESTION 4.3.2. (2)

4.4 The alkane is identified as pentane. Will the boiling point of hexane be HIGHER THAN or LOWER THAN that of pentane? Refer to MOLECULAR STRUCTURE, INTERMOLECULAR FORCES and ENERGY needed to explain the answer. (4)

[11]

QUESTION 5 (Start on a new page.)

Two straight chain compounds, **P** and **Q**, each have the following molecular formula:

P: C_4H_{10}

Q: C_4H_8

5.1 Write down the name of the homologous series to which **Q** belongs. (1)

5.2 Compound **P** reacts with chlorine to form 2-chlorobutane.

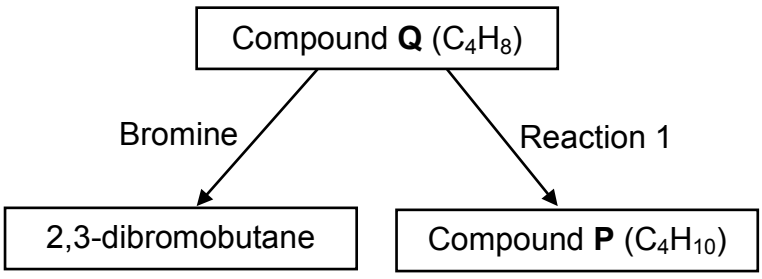
Write down:

5.2.1 A balanced chemical equation, using MOLECULAR FORMULAE, for the reaction that takes place (3)

5.2.2 The type of reaction that takes place (1)

5.2.3 One reaction condition (other than the solvent needed) (1)

5.3 Compound **Q** takes part in reactions as shown in the flow diagram below.



Write down the:

5.3.1 Structural formula for 2,3-dibromobutane (2)

5.3.2 IUPAC name of compound **Q** (2)

5.3.3 Balanced equation, using structural formulae, for **reaction 1** (4)

5.3.4 Type of reaction that occurs in **reaction 1** (1)

[15]

QUESTION 6 (Start on a new page.)

A hydrogen peroxide solution dissociates slowly at room temperature according to the following equation:

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$

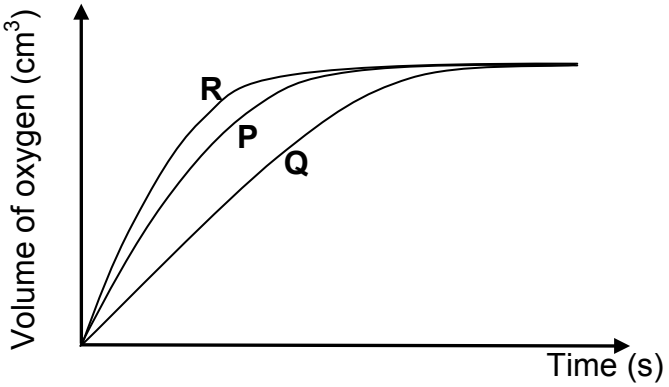
During an investigation, learners compare the effectiveness of three different catalysts on the rate of decomposition of hydrogen peroxide. They place EQUAL AMOUNTS of sufficient hydrogen peroxide into three separate containers. They then add EQUAL AMOUNTS of the three catalysts, **P**, **Q** and **R**, to the hydrogen peroxide in the three containers respectively and measure the rate at which oxygen gas is produced.

6.1 For this investigation, write down the:

6.1.1 Independent variable (1)

6.1.2 Dependent variable (1)

The results obtained are shown in the graph below.



6.2 Which catalyst is the most effective? Give a reason for the answer. (2)

6.3 Fully explain, by referring to the collision theory, how a catalyst increases the rate of a reaction. (3)

In another experiment, the learners obtain the following results for the decomposition of hydrogen peroxide:

TIME (s)	H_2O_2 CONCENTRATION ($mol \cdot dm^{-3}$)
0	0,0200
200	0,0160
400	0,0131
600	0,0106
800	0,0086

6.4 Calculate the AVERAGE rate of decomposition (in $mol \cdot dm^{-3} \cdot s^{-1}$) of $H_2O_2(aq)$ in the first 400 s. (3)

6.5 Will the rate of decomposition at 600 s be GREATER THAN, LESS THAN or EQUAL TO the rate calculated in QUESTION 6.4? Give a reason for the answer. (2)

6.6 Calculate the mass of oxygen produced in the first 600 s if 50 cm^3 of hydrogen peroxide decomposes in this time interval. (5)

[17]

QUESTION 7 (Start on a new page.)

A chemical engineer studies the reaction of nitrogen and oxygen in a laboratory. The reaction reaches equilibrium in a closed container at a certain temperature, **T**, according to the following balanced equation:

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$

Initially, 2 mol of nitrogen and 2 mol of oxygen are mixed in a 5 dm^3 sealed container. The equilibrium constant (K_C) for the reaction at this temperature is $1,2 \times 10^{-4}$.

7.1 Is the yield of NO(g) at temperature **T** HIGH or LOW? Give a reason for the answer. (2)

7.2 Calculate the equilibrium concentration of NO(g) at this temperature. (8)

7.3 How will each of the following changes affect the YIELD of NO(g)? Write down only INCREASES, DECREASES or REMAINS THE SAME.

7.3.1 The volume of the reaction vessel is decreased at constant temperature. (1)

7.3.2 An inert gas such as argon is added to the mixture. (1)

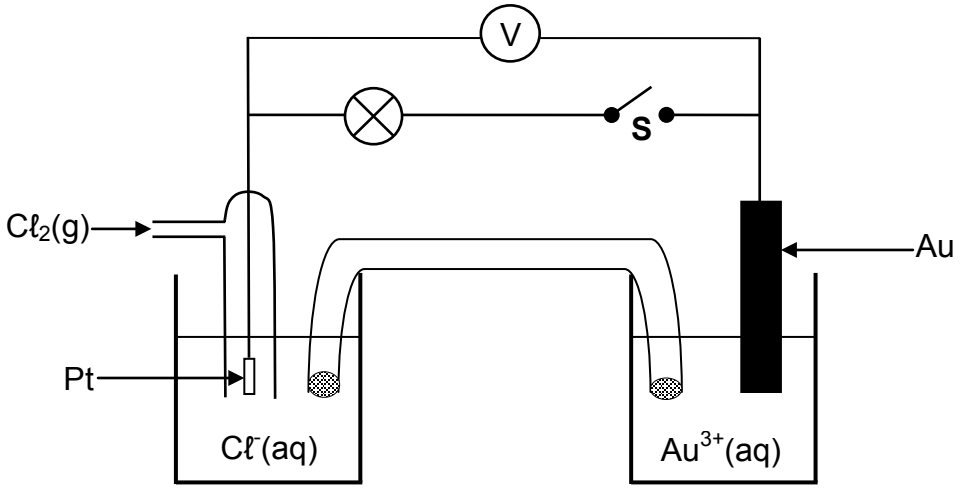
7.4 It is found that K_C of the reaction increases with an increase in temperature. Is this reaction exothermic or endothermic? Explain the answer. (3)

[15]

QUESTION 8 (Start on a new page.)

The diagram below shows a galvanic cell operating under standard conditions. The cell reaction taking place when the cell is functioning is:

$$6C\ell^-(aq) + 2Au^{3+}(aq) \rightarrow 3C\ell_2(g) + 2Au(s)$$



With switch **S** OPEN, the initial reading on the voltmeter is 0,14 V.

8.1 Write down the:

8.1.1 NAME or FORMULA of the oxidising agent (1)

8.1.2 Half-reaction which takes place at the anode (2)

8.1.3 Cell notation for this cell (3)

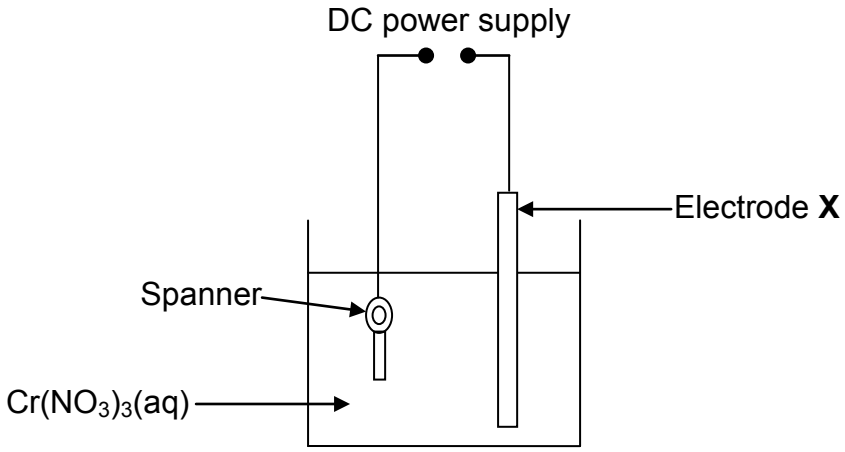
8.2 Calculate the standard reduction potential of Au. (4)

Switch **S** is now closed and the bulb lights up.

8.3 How will the reading on the voltmeter now compare to the INITIAL reading of 0,14 V? Write down only LARGER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (2)
[12]

QUESTION 9 (Start on a new page.)

The diagram below represents a simplified electrolytic cell used to electroplate a spanner with chromium. The spanner is continuously rotated during the process of electroplating.



A constant current passes through the solution and the concentration of $Cr(NO_3)_3(aq)$ remains constant during the process. In the process, a total of 0,03 moles of electrons is transferred in the electrolytic cell.

9.1 Define the term *electrolysis*. (2)

9.2 Write down the:

9.2.1 Half-reaction that occurs at the spanner (2)

9.2.2 NAME or FORMULA of the metal of which electrode **X** is made (1)

9.2.3 NAME or FORMULA of the oxidising agent (1)

9.3 Calculate the gain in mass of the spanner. (4)
[10]

QUESTION 10 (Start on a new page.)

Lead-acid batteries consist of several cells. A sulphuric acid solution is used as electrolyte in these batteries.

10.1 Define the term *electrolyte.* (2)

The standard reduction potentials for the half-reactions that take place in a cell of a lead-acid battery are as follows:

$PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightleftharpoons PbSO_4(s) + 2H_2O(\ell)$ $E^\theta = +1,69$ V

$PbSO_4(s) + 2e^- \rightleftharpoons Pb(s) + SO_4^{2-}(aq)$ $E^\theta = -0,36$ V

10.2 Write down the half-reaction that takes place at the anode of this cell. (2)

10.3 Write down the overall cell reaction when the cell delivers current. (3)

10.4 A number of the cells above are connected in series to form a 300 V battery which operates at standard conditions.

Calculate the:

10.4.1 Maximum energy stored in the battery if its capacity is 7 500 A·h (5)

10.4.2 Minimum number of cells in this battery (5)
[17]

QUESTION 11 (Start on a new page.)

11.1 A farmer wants to produce the following fruit and vegetables for the market:

spinach; potatoes; apples

Write down the NAME of the most important primary nutrient required to enhance:

11.1.1 Root growth of potato plants (1)

11.1.2 Leaf growth of spinach (1)

11.1.3 Flower and fruit production of apple trees (1)

11.2 Ammonia must be produced in large quantities to produce nitrogen-based fertilisers.

11.2.1 Write down the name of the process used in the industrial preparation of ammonia. (1)

11.2.2 Write down a balanced chemical equation for the reaction that takes place in the process named in QUESTION 11.2.1. (3)

11.3 Ammonium hydrogen phosphate, $(NH_4)_2HPO_4$, is a type of fertiliser used in agriculture.

Refer to the type of elements of which this fertiliser is composed to give a reason why it will be advantageous for a farmer to use this fertiliser instead of a fertiliser such as ammonium nitrate, NH_4NO_3. (2)

11.4 Describe ONE negative impact on humans when fertiliser runs off into dams and rivers as a result of rain. (2)

[11]

TOTAL SECTION B: 125
GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$
$q = I \Delta t$ $W = Vq$	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\,agent} - E^{\theta}_{reducing\,agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 **H** 1																	**He** 4
1,0 **Li** 7	1,5 **Be** 9											2,0 **B** 11	2,5 **C** 12	3,0 **N** 14	3,5 **O** 16	4,0 **F** 19	**Ne** 20
0,9 **Na** 23	1,2 **Mg** 24											1,5 **Aℓ** 27	1,8 **Si** 28	2,1 **P** 31	2,5 **S** 32	3,0 **Cℓ** 35,5	**Ar** 40
0,8 **K** 39	1,0 **Ca** 40	1,3 **Sc** 45	1,5 **Ti** 48	1,6 **V** 51	1,6 **Cr** 52	1,5 **Mn** 55	1,8 **Fe** 56	1,8 **Co** 59	1,8 **Ni** 59	1,9 **Cu** 63,5	1,6 **Zn** 65	1,6 **Ga** 70	1,8 **Ge** 73	2,0 **As** 75	2,4 **Se** 79	2,8 **Br** 80	**Kr** 84
0,8 **Rb** 86	1,0 **Sr** 88	1,2 **Y** 89	1,4 **Zr** 91	**Nb** 92	1,8 **Mo** 96	1,9 **Tc**	2,2 **Ru** 101	2,2 **Rh** 103	2,2 **Pd** 106	1,9 **Ag** 108	1,7 **Cd** 112	1,7 **In** 115	1,8 **Sn** 119	1,9 **Sb** 122	2,1 **Te** 128	2,5 **I** 127	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**Ac**															

Ce 140	**Pr** 141	**Nd** 144	**Pm**	**Sm** 150	**Eu** 152	**Gd** 157	**Tb** 159	**Dy** 163	**Ho** 165	**Er** 167	**Tm** 169	**Yb** 173	**Lu** 175
Th 232	**Pa**	**U** 238	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

Electronegativity *Elektronegatiwiteit* → 29 / 1,9 Cu / 63,5 ← Symbol *Simbool*

Approximate relative atomic mass *Benaderde relatiewe atoommassa*

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Half-reactions/*Halfreaksies*			$E^{\ominus}$ (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Half-reactions/*Halfreaksies*	$E^{\ominus}$ (V)
$Li^+ + e^- \rightleftharpoons Li$	– 3,05
$K^+ + e^- \rightleftharpoons K$	– 2,93
$Cs^+ + e^- \rightleftharpoons Cs$	– 2,92
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	– 2,90
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	– 2,89
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	– 2,87
$Na^+ + e^- \rightleftharpoons Na$	– 2,71
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	– 2,36
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	– 1,66
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	– 1,18
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	– 0,91
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	– 0,76
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	– 0,74
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	– 0,44
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	– 0,41
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	– 0,40
$Co^{2+} + 2e^- \rightleftharpoons Co$	– 0,28
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	– 0,27
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	– 0,14
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	– 0,13
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	– 0,06
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**0,00**
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2013

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 15 pages.
Hierdie memorandum bestaan uit 15 bladsye.

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 Fractional distillation / *Fraksionele distillasie* ✓ (1)

1.2 Dehydration / *Dehidratering / Dehidrasie* ✓ (1)

1.3 Collision (theory) / *Botsings(teorie)* ✓ (1)

1.4 Reducing agent / *Reduseermiddel* ✓ (1)

1.5 Homologous series / *Homoloë reeks* ✓ (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 C ✓✓ (2)

2.2 C ✓✓ (2)

2.3 A ✓✓ (2)

2.4 D ✓✓ (2)

2.5 B ✓✓ (2)

2.6 C ✓✓ (2)

2.7 A ✓✓ (2)

2.8 D ✓✓ (2)

2.9 B ✓✓ (2)

2.10 C ✓✓ (2)
[20]

TOTAL SECTION/TOTAAL AFDELING A: 25

SECTION B/*AFDELING B*

QUESTION 3/*VRAAG 3*

3.1

3.1.1 A ✓
C ✓ (2)

3.1.2 B ✓ (1)

3.1.3 F ✓ (1)

3.1.4 F ✓✓ (2)

3.2

3.2.1 4,5-dimethyl✓hex-2-ene ✓ / *4,5-dimetiel✓heks-2-een* ✓

OR/*OF*

4,5-dimethyl✓-2-hexene ✓ / *4,5-dimetiel✓-2-hekseen* ✓ (2)

3.2.2 2,3-dibromo-5-methyl✓heptane ✓ / *2,3-dibromo-5-metiel✓heptaan* ✓ (2)

3.2.3 4-methyl✓pent-2-yne ✓ / *4-metielpent-2-yn*

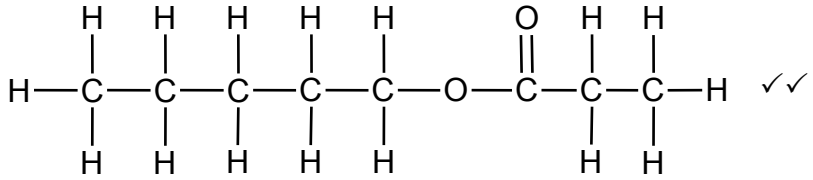
OR/*OF*

4-methyl✓-2-pentyne ✓ / *4-metielpent-2-yn* (2)

3.3

3.3.1 Esters ✓ (1)

3.3.2



✓✓ (2)

3.3.3 Propanoic acid / *Propanoësuur* ✓ (1)

3.3.4 Sulphuric acid / *Swawelsuur* / H_2SO_4 ✓ (1)

[17]

QUESTION 4/*VRAAG 4*

4.1

4.1.1 Samples / Contents of bottle / (Type of) compound / functional group / homologous series ✓
Monsters / Inhoud van bottel / (Tipe) verbinding / funksionele groep / homoloë reeks (1)

4.1.2 Boiling point / *Kookpunt* ✓ (1)

4.2 ... comparable molecular mass. / *... vergelykbare molekulêre massa*. ✓

OR/*OF*
... under the same conditions ... / *... onder dieselfde toestande ...* (1)

4.3

4.3.1 Q ✓ (1)

4.3.2 R ✓ (1)

4.3.3
- R has the highest boiling point. / *R het die hoogste kookpunt*. ✓
- In addition to weak Van der Waals forces, alcohols also have strong hydrogen bonds between molecules. ✓
  Bo en behalwe swak Van der Waalskragte, het alkohole ook sterk waterstofbindings tussen molekule. (2)

4.4 Higher than ✓

- **Structure:**
  Longer chain length. / More C atoms in chain. / Greater molecular size. / Greater molecular mass. / Larger surface area. ✓
- **Intermolecular forces:**
  Stronger or more intermolecular forces /Van der Waals forces / dispersion forces / London forces. ✓
- **Energy:**
  More energy needed to overcome or break intermolecular forces/ Van der . Waals forces / dispersion forces / London forces.✓

Hoër as

- ***Struktuur:***
  Langer kettinglengte. / Meer C-atome in kettting. / Groter molekule. / Groter molekulêre massa. / Groter reaksieoppervlakte.
- ***Intermolekulêre kragte:***
  Sterker of meer intermolekulêre kragte/ Van der Waalskragte / dispersiekragte / Londonkragte.
- ***Energie:***
  Meer energie benodig om intermolekulêre kragte/ Van der Waalskragte/ dispersiekragte / Londonkragte te oorkom of breek.

OR/*OF*

Higher than ✓

- **Structure:**
  Pentane has a shorter chain length. / Less C atoms in chain. / Smaller molecular size. / Smaller molecular mass. / Smaller surface area. ✓
- **Intermolecular forces:**
  Weaker or less intermolecular forces / Van der Waals forces / dispersion forces / London forces. ✓
- **Energy:**
  Less energy needed to overcome or break intermolecular forces / Van der Waals forces / dispersion forces / London forces. ✓

Hoër as

- ***Struktuur:***
  ***Pentaan** het 'n korter kettinglengte. / Minder C-atome in kettting. / Kleiner molekule. / Kleiner molekulêre massa. / Kleiner reaksieoppervlakte.*
- ***Intermolekulêre kragte:***
  Swakker of minder intermolekulêre kragte/ Van der Waalskragte/ dispersiekragte / Londonkragte .
- ***Energie:***
  Minder energie benodig om intermolekulêre kragte/Van der Waalskragte / dispersiekragte / Londonkragte te oorkom of breek.

(4)
[11]

QUESTION 5/*VRAAG 5*

5.1 Alkenes / *Alkene* ✓ (1)

5.2

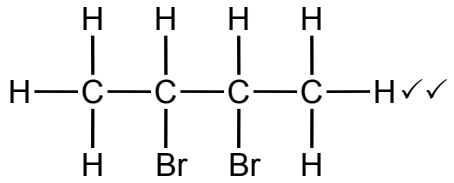
5.2.1 $C_4H_{10} + C\ell_2$ ✓ $\rightarrow C_4H_9C\ell + HC\ell$ ✓ Bal. ✓ (3)

5.2.2 Halogenation / Substitution / Chlorination ✓
Halogenering / Halogenasie / Substitusie / Chlorinering (1)

5.2.3 Heat **OR** (sun)light (UV) / hf ✓
*Hitte **OF** (son)lig (UV) / hf* (1)

5.3

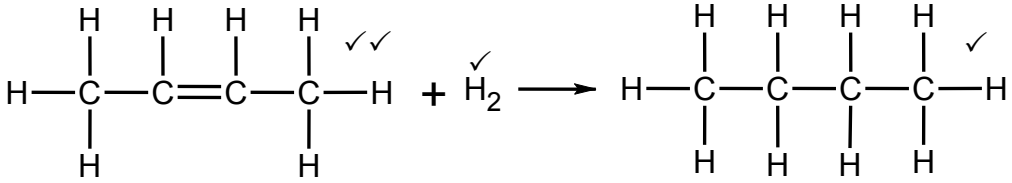
5.3.1



(2)

5.3.2 But-2-ene / 2-butene ✓✓
But-2-een / 2-buteen (2)

5.3.3



(4)

5.3.4 Hydrogenation / Addition ✓
Hidrogenering / Hidrogenasie / Addisie (1)

[15]

QUESTION 6/*VRAAG 6*

6.1

6.1.1 (Type of) catalyst / *(Tipe) katalisator* ✓ (1)

6.1.2 Rate (of reaction) / *(Reaksie)tempo* ✓ (1)

6.2 R ✓
Fastest rate. / Steepest (initial) gradient or slope. /Produces oxygen faster/est / reaches completion faster OR fastest OR in a shorter time ✓
Vinnigste tempo. / Steilste (aanvanklike) gradiënt of helling./ Produseer suurstof vinnigste/er/ bereik voltooiing vinnigste OF vinniger OF in 'n korter tyd.✓ (2)

6.3
- A catalyst provides an alternative pathway of lower activation energy. ✓
  'n Katalisator voorsien 'n alternatiewe pad van laer aktiveringsenergie.
- More molecules have sufficient/enough kinetic energy. / *Meer molekule het voldoende/genoeg kinetiese energie.* ✓
  OR/*OF*
  More molecules have kinetic energy equal to or greater than the activation energy.
  Meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.
- More effective collisions per unit time./ Rate of effective collisions increases.
  Meer effektiewe botsings per eenheidstyd./ Tempo van effektiewe botsings neem toe. ✓/ (3)

6.4

$$\text{Average rate/}\textit{Gemiddelde tempo} = \frac{\Delta[H_2O_2]}{\Delta t}$$
$$= \frac{0{,}0131 - 0{,}020}{400 - (0)} \checkmark$$
$$= -\,1{,}73 \times 10^{-5}\ \text{mol}\cdot\text{dm}^{-3}\cdot\text{s}^{-1} \checkmark$$
OR/*OF*
$$1{,}73 \times 10^{-5}\ \text{mol}\cdot\text{dm}^{-3}\cdot\text{s}^{-1}$$ (3)

6.5 Less than / *Kleiner as* ✓
The concentration of hydrogen peroxide decreases as the reaction proceeds. ✓
Die konsentrasie van die waterstofperoksied verminder soos wat die reaksie verloop. (2)

6.6

Mark allocation/*Puntetoekenning:*

- $c = \frac{n}{V}$ or/*of* $n = \frac{m}{M}$ or/*of* $c = \frac{m}{MV}$ ✓
- Substitute / *Vervang* (0,0200 - 0,0106) and/*en* 50 x 10^{-3} ✓
- $n(O_2) = ½n(H_2O_2)$ ✓
- Using/*Gebruik* M = 32 in m = nM or/*of* cMV or/*of* a ratio calculation / *'n verhouding berekening* ✓
- Final answer/*Finale antwoord*: 7,52 x 10^{-3} g / 0,008 g / 0,01 g✓

OPTION 1/*OPSIE 1*

$c = \frac{n}{V}$ ✓

(0,0200 - 0,0106) = $\frac{n}{50 \times 10^{-3}}$ ✓

$\therefore$ n = 4,7 x 10^{-4} mol

$n(O_2) = ½n(H_2O_2) = ½(4,7 \times 10^{-4})$ ✓
= 2,35 x 10^{-4} mol

$n(O_2) = \frac{m}{M}$

2,35 x 10^{-4} = $\frac{m}{32}$ ✓

$\therefore$ $m(O_2)$ = 7,52 x 10^{-3} g
= (0,008 g) = (0,01 g) ✓

OPTION 2/*OPSIE 2*

$\Delta c(H_2O_2)$ = 0,0200 – 0,0106
= 0,0094

$\Delta c(O_2) = ½\Delta c(H_2O_2)$
= ½(0,0094) ✓
= 0,0047

c = $\frac{m}{MV}$ ✓

$\Delta m(O_2)$ = cMV
= (0,0047)(32) ✓ (50 x 10^{-3}) ✓
= 7,52 x 10^{-3} g
= 0,008 g
= 0,01g✓

(5)
[17]

QUESTION 7/*VRAAG 7*

7.1 Low / *Laag* ✓
Small K_c value. / *Klein K_c-waarde*. ✓
K_c is smaller than 1/ *K_c is kleiner as 1* (2)

7.2 **CALCULATIONS USING NUMBER OF MOLES:**
BEREKENINGE WAT GETAL MOL GEBRUIK:

Mark allocation/*Puntetoekenning:*

- **USING** ratio/***GEBRUIK*** *verhouding:* $N_2 : O_2 : NO = x : x : 2x$ ✓
- Equilibrium/*Ewewig:* $n(N_2)$ = initial/*aanvanklik* – change/*verandering*
  Equilibrium/*Ewewig*: $n(O_2)$ = initial/*aanvanklik* – change/*verandering* ✓
- Equilibrium/*Ewewig*: n(NO) = initial/*aanvanklik* + change/*verandering* ✓
- Divide $n(N_2)$, $n(O_2)$ & n(NO) by 5 dm^3. ✓
  Deel $n(N_2)$, $n(O_2)$ & n(NO) deur 5 dm^3.
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c-uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
  Vervanging van konsentrasies in K_c-uitdrukking.
- Substitution of K_c value. ✓
  Vervanging van K_c-waarde .
- Final answer/*Finale antwoord*: $4,36 \times 10^{-3}$ mol·dm^{-3} ✓ ($0,004$ mol·dm^{-3})

OPTION 1/*OPSIE 1*

	N_2	O_2	NO	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	2	2	0	
Change (mol) *Verandering (mol)*	x	x	2x	ratio ✓
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	2-x	2-x ✓	2x ✓	
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	$\frac{2-x}{5}$	$\frac{2-x}{5}$	$\frac{2x}{5}$	Divide by 5 ✓

$$K_C = \frac{[NO]^2}{[N_2][O_2]} \checkmark \quad \therefore 1,2 \times 10^{-4} \checkmark = \frac{\left(\frac{2x}{5}\right)^2}{\left(\frac{2-x}{5}\right)\left(\frac{2-x}{5}\right)} \checkmark \quad \frac{0,4^2}{0,2^2}$$

$$\therefore x = 0,0109 \text{ mol}$$

$$\therefore [NO] = \frac{2(0,0109)}{5} = 4,36 \times 10^{-3} \text{ mol·dm}^{-3} \checkmark (0,004 \text{ mol·dm}^{-3})$$

OPTION 2/*OPSIE 2*

	N_2	O_2	NO	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	2	2	0	
Change (mol) *Verandering (mol)*	$\frac{x}{2}$	$\frac{x}{2}$	x	ratio ✓
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	$2-\frac{x}{2}$	$2-\frac{x}{2}$ ✓	x ✓	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	$\frac{4-x}{10}$	$\frac{4-x}{10}$	$\frac{x}{5}$	Divide by 5 ✓

$$K_C = \frac{[NO]^2}{[N_2][O_2]} \checkmark$$

$$\therefore 1,2 \times 10^{-4} \checkmark = \frac{\left(\frac{x}{5}\right)^2}{\left(\frac{4-x}{10}\right)\left(\frac{4-x}{10}\right)} \checkmark$$

$$\therefore x = 0,022 \text{ mol}$$

$$\therefore [NO] = \frac{0,022}{5} = 4,36 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \checkmark (0,004 \text{ mol} \cdot \text{dm}^{-3})$$

OPTION 3/*OPSIE 3*

	N_2	O_2	NO	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	2	2	0	
Change (mol) *Verandering (mol)*	$\frac{5x}{2}$	$\frac{5x}{2}$	5x	ratio ✓
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	$2-\frac{5x}{2}$	$2-\frac{5x}{2}$ ✓	5x ✓	
Equilibrium concentration / Ewewigskonsentrasie ($mol \cdot dm^{-3}$)	$\frac{4-5x}{10}$	$\frac{4-5x}{10}$	x	Divide by 5 ✓

$$K_C = \frac{[NO]^2}{[N_2][O_2]} \checkmark$$

$$\therefore 1,2 \times 10^{-4} \checkmark = \frac{(x)^2}{\left(\frac{4-5x}{10}\right)\left(\frac{4-5x}{10}\right)} \checkmark$$

$$\therefore x = 4,36 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \checkmark (0,004 \text{ mol} \cdot \text{dm}^{-3})$$

CALCULATIONS USING CONCENTRATIONS
BEREKENINGE WAT KONSENTRASIES GEBRUIK

Mark allocation/*Puntetoekenning*

- Divide $n(N_2)$ & $n(O_2)$ by 5 dm^3. ✓
  Deel $n(N_2)$ & $n(O_2)$ deur 5 dm^3.
- **USING** ratio/***GEBRUIK*** *verhouding:* $N_2 : O_2 : NO = 1 : 1 : 2$ ✓
- Equilibrium/*Ewewig:* $c(N_2)$ = initial/*aanvanklik* – change/*verandering*
  Equilibrium/*Ewewig*: $c(O_2)$ = initial/*aanvanklik* – change/*verandering*
  Equilibrium/*Ewewig*: c(NO) = initial/*aanvanklik* + change/*verandering* ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c-uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
  Vervanging van konsentrasies in K_c-uitdrukking.
- Substitution of K_c value ✓
  Vervanging van K_c-waarde
- Calculate c(NO) i.e. 2 x answer of K_c calculation. ✓
  Bereken c(NO) d.i. 2 x antwoord van K_c-berekening.
- Final answer/*Finale antwoord*: $4{,}36 \times 10^{-3}$ mol·dm^{-3} ✓ (0,004 mol·dm^{-3})

OPTION 3/*OPSIE 3*

	N_2	O_2	NO	
Initial concentration (mol·dm^{-3}) *Aanvangskonsentrasie (mol·dm^{-3})*	0,4	0,4	0	Divide by 5 ✓
Change (mol·dm^{-3}) *Verandering* (mol·dm^{-3})	x	x	2x	ratio ✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,4-x	0,4-x ✓	2x✓	

$$K_C = \frac{[NO]^2}{[N_2][O_2]^2} \checkmark$$

$$\therefore 1{,}2 \times 10^{-4} \checkmark = \frac{(2x)^2}{(0{,}4 - x)(0{,}4 - x)} \checkmark$$

$\therefore x = 2{,}18 \times 10^{-3}$ mol·dm^{-3} (0,00218 mol·dm^{-3})

$\therefore$ [NO] = $2(2{,}18 \times 10^{-3}) = 4{,}36 \times 10^{-3}$ mol·dm^{-3} ✓ (0,004 mol·dm^{-3})

(8)

7.3

7.3.1 Remains the same / *Bly dieselfde* ✓ (1)

7.3.2 Remains the same / *Bly dieselfde* ✓ (1)

7.4 Endothermic / *Endotermies* ✓
- (An increase in K_C implies) an increase in concentration of products. ✓
  ('n Toename in K_c impliseer)'n toename in die konsentrasie van produkte.
  OR/*OF*
  (An increase in K_C implies) that the forward reaction is favoured.
  ('n Toename in K_c impliseer) dat die voorwaartse reaksie bevoordeel is.
  OR/*OF*
  (An increase in K_C implies) the equilibrium position shifts to the right.
  ('n Toename in K_c impliseer) dat die ewewigsposisie na regs geskuif het.
- An increase in temperature favours an endothermic reaction. ✓
  'n Toename in temperatuur bevoordeel die endotermiese reaksie.

(3) **[15]**

QUESTION 8/*VRAAG 8*

8.1

8.1.1 Au^{3+} / gold(III) ion ✓
Au^{3+} / goud(III)-ioon (1)

8.1.2 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓✓ (2)

Notes/*Aantekeninge*
- $2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ ($\frac{1}{2}$)
- $2C\ell^- \leftarrow C\ell_2 + 2e^-$ ($\frac{0}{2}$)
- $C\ell_2 + 2e^- \leftarrow 2C\ell^-$ ($\frac{2}{2}$)
- $C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ ($\frac{0}{2}$)

8.1.3 $Pt(s) \mid C\ell^-$ (1 mol·dm^{-3}) $\mid C\ell_2(g) \parallel Au^{3+}$(1 mol·dm^{-3}) $\mid Au(s)$ ✓ ✓ ✓

OR/*OF*

$Pt(s) \mid C\ell^-(aq) \mid C\ell_2(g) \parallel Au^{3+}(aq) \mid Au(s)$

OR/*OF*

$Pt \mid C\ell^- \mid C\ell_2 \parallel Au^{3+} \mid Au$ (3)

8.2 **Option 1/*Opsie 1***

$E^o_{cell} = E^o_{cathode} - E^o_{anode}$ ✓
$0,14$ ✓ $= E^o_{cathode} - (1,36)$ ✓
$E^o_{cathode} = 1,50$ V ✓

Option 2/*Opsie 2*

✓ $2C\ell^- \rightarrow C\ell_2 + 2e^-$ $E° = -1,36$ ✓
$Au^{3+} + 3e^- \rightarrow Au$ $E° = +1,50$ ✓
$E° = 0,14$ V ✓ (4)

8.3 Smaller than / *Kleiner as* ✓
Decrease or drop in potential difference or voltage due to internal resistance or "lost volts". ✓
Val of afname in potensiaalverskil of spanning as gevolg van interne weerstand of "velore volts". (2)

[12]

QUESTION 9/*VRAAG 9*

9.1 The chemical process in which electrical energy is converted to chemical energy.✓✓
Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.

OR/*OF*
The use of electrical energy to produce chemical change. ✓✓
Die gebruik van elektriese energie om chemiese verandering te weeg te bring. (2)

9.2

9.2.1 $Cr^{3+} + 3e^- \rightarrow Cr(s)$ ✓✓ (2)

9.2.2 Cr / chromium / *chroom* ✓ (1)

9.2.3 Chromium(III) ions / *chroom(III)-ione* / Cr^{3+} ✓ (1)

9.3

Mark allocation/*Puntetoekenning:*
- $n = \frac{m}{M}$ or using ratio / *of gebruik van verhouding* ✓
- Ratio: 1 : 3 (1 mole Cr^{3+} gains 3 mole of electrons) ✓
  Verhouding 1: 3 (1 mol Cr^{3+} neem 3 mol elektrone op)
- Using M = 52 in m = nM or in ratio calculation. ✓
  Gebruik M = 52 in m = nM of verhouding berekening .
- Final answer/*Finale antwoord*: 0,52 g ✓

$n = \frac{m}{M}$ ✓

$\left(\frac{0,03}{3}\right)$ ✓$= \frac{m}{52}$ ✓ **OR/*OF*** 0,01 ✓$= \frac{m}{52}$ ✓

$\therefore m = 0,52$ g ✓

OR/*OF*
3 mol e^- ..... 52 g ✓ Cr
0,03 mol e^- ..... $\left(\frac{0,03}{3}\right)$ ✓ (52) ✓ = 0,52 g ✓

(4)
[10]

QUESTION 10/*VRAAG 10*

10.1 A solution which conducts electricty through the movement of ions. ✓✓
'n Oplossing wat elektrisiteit gelei deur die beweging van ione. (2)

10.2 $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$ ✓✓ (2)

10.3 $PbO_2(s) + Pb(s) + 2SO_4^{2-}(aq) + 4H^+(aq)$ ✓→ $2PbSO_4(s) + 2H_2O(\ell)$ ✓ bal. ✓

OR/OF

$PbO_2(s) + Pb(s) + 2H_2SO_4(aq)$ ✓→ $2PbSO_4(s) + 2H_2O(\ell)$ ✓ bal. ✓ (3)

10.4

10.4.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$Q = I\Delta t$ $= (7\ 500)$ ✓ $(3\ 600)$ ✓ $= 2{,}7 \times 10^7$ C $W = VQ$ ✓ $= (300)$ ✓ $(2{,}7 \times 10^7)$ $= 8{,}1 \times 10^9$ J ✓	$W = VI\Delta t$ ✓ $= (300)$✓ (7500) ✓ (3600) ✓ $= 8{,}1 \times 10^9$ J ✓

(5)

10.4.2 $E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ ✓
$= +1{,}69$ ✓$- (-0{,}36)$ ✓
$= +2{,}05$ V

$$\text{No. cells} = \frac{300}{2{,}05} \checkmark$$

$= 146{,}34$ cells/*selle*

$\therefore$ 147 cells / *selle* ✓ (5)
[17]

QUESTION 11/*VRAAG 11*

11.1
11.1.1 Phosphorous / *Fosfor* / P ✓ (1)

11.1.2 Nitrogen / *Stikstof* / N ✓ (1)

11.1.3 Potassium / *Kalium* / K ✓ (1)

11.2
11.2.1 Haber (process)/(*proses)* ✓ (1)

11.2.2 $N_2(g) + 3H_2(g)$ ✓ $\rightleftharpoons 2NH_3(g)$ ✓ bal. ✓ (3)

11.3 The fertiliser contains two primary nutrients N/nitrogen and P/ phosphorous, ✓ whereas the ammonium nitrate contains only N/nitrogen. ✓
Die kunsmis bevat twee primêre nutriente N en P terwyl ammoniumnitraat slegs N bevat. (2)

11.4 **ANY ONE /*ENIGE EEN***

- Fertilisers in water leads to eutrophication which can result in less drinking water / starvation due to dying of fish / less water recreation areas. ✓
  Kunsmis in water lei tot eutrofisering / eutrofikasie wat minder drinkwater // hongersnood weens visvrektes /minder ontspanningsgebiede tot gevolg kan hê.
- Fertilisers in water leads to excess of nitrates in water ✓ resulting in blue baby syndrome / cancer. ✓
  Kunsmis in water lei tot oormaat nitrate in water wat lei tot bloubabasindroom / kanker.

(2)
[11]

TOTAL SECTION B/*TOTAAL AFDELING B:* 125
GRAND TOTAL/*GROOTTOTAAL*: 150