education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

Grade 12

Supplementary Study Material

Physical science

Together Educating the Nation

Physical Sciences: Physics P1
November 2009

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the spaces on the ANSWER BOOK.
2. Answer ALL the questions.
3. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)
4. Answer SECTION A and SECTION B in the ANSWER BOOK.
5. Non-programmable calculators may be used.
6. Appropriate mathematical instruments may be used.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Data sheets are attached for your use.
9. Give brief motivations, discussions, et cetera where required.

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 energy of a stationary object due to its position above the surface of the earth (1)

1.2 The unit of measurement equal to one joule per second (1)

1.3 The term used to describe two light sources that emit waves that maintain the same phase relationship with each other (1)

1.4 Electromagnetic waves with the highest penetrating ability (1)

1.5 The 'packets of energy' making up electromagnetic radiation (1)
[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Correct each statement so that it is TRUE. Write only the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example " IS NOT ", will not be accepted.

2.1 The magnitude of the acceleration of an object projected vertically upwards from the ground is zero at its maximum height. (2)

2.2 When a bullet is fired from a gun, the momentum of the bullet is the same as the momentum of the gun. (2)

2.3 Dispersion of white light by the parallel tracks on the surface of a CD is the result of refraction. (2)

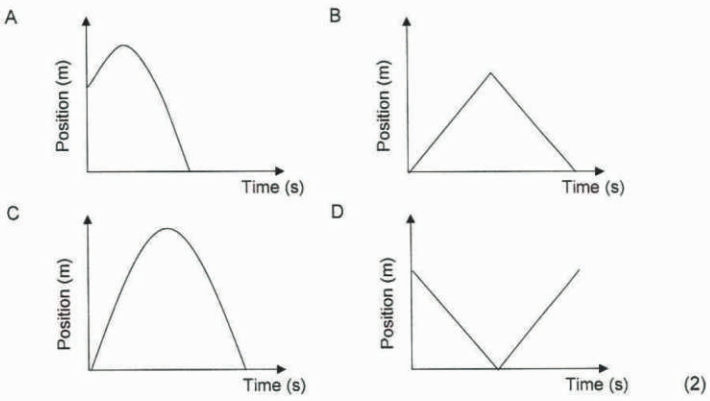
2.4 Non-identical resistors connected in series have the same current in them and the same potential difference across each of them. (2)

2.5 A line emission spectrum is formed when electrons in an atom move from lower to higher energy levels. (2)
[10]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS

Four options are given 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 (3.1 – 3.5) in the ANSWER BOOK.

3.1 A stone is thrown vertically upwards and returns to the thrower's hand after a while. Which ONE of the following position-versus-time graphs best represents the motion of the stone?

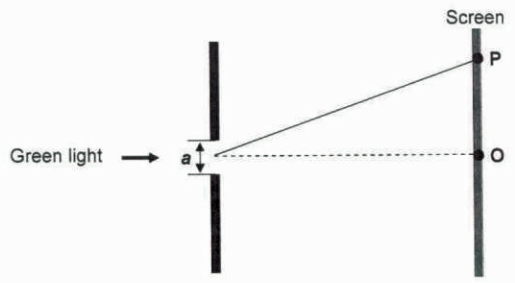


(2)

3.2 Car A moves west at speed *v*. Car B moves east at speed 2*v* along the same straight road. The velocity of Car A relative to Car B is:

A 3*v* west
B 3*v* east
C *v* east
D *v* west (2)

3.3 Green light passes through a narrow slit of width *a*. The first minimum is observed at point P on a screen as shown in the diagram below.

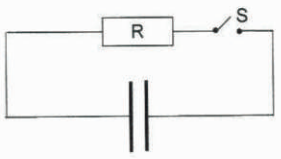


Which ONE of the following changes regarding the colour of the incident light and the width of the slit will cause the GREATEST increase in the distance OP?

	Colour of light	Width of slit
A	Red	2*a*
B	Red	½*a*
C	Blue	2*a*
D	Blue	½*a*

(2)

3.4 A fully charged capacitor is connected to a resistor *R* in a circuit, as shown below.

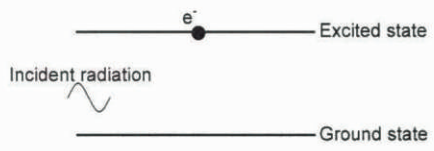


Which ONE of the following correctly describes the changes in the current, *I*, in the circuit and the potential difference, *V*, across the capacitor when the switch S is closed?

	I	*V*
A	Decreases	Increases
B	Increases	Decreases
C	Decreases	Decreases
D	Increases	Increases

(2)

3.5 The diagram below represents part of the process of stimulated emission in a laser. An electron in an atom of the lasing material is shown in the excited state, with radiation incident on the lasing material.



The radiation emitted by the electron when dropping to the ground state will be

A in phase and in the same direction as the incident radiation.

B in phase and opposite in direction to the incident radiation.

C out of phase and in the same direction as the incident radiation.

D out of phase and opposite in direction to the incident radiation. (2)
[10]

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 4.1 and QUESTION 4.2.
3. The formulae and substitutions must be shown in ALL calculations.
4. Round off your answers to TWO decimal places where applicable.

QUESTION 4 (Start on a new page.)

The following extract comes from an article in a school newspaper.

THE LAWS OF PHYSICS ARE ACCURATE!

Two construction workers, Alex and Pete, were arguing about whether a smaller brick would hit the ground quicker than a larger brick when both are released from the same height.

Alex said that the larger brick should hit the ground first. Pete argued that the smaller brick would hit the ground first.

4.1 Are their statements correct? Give a reason for your answer. (3)

4.2 A group of Physical Sciences learners decide to test Alex's and Pete's hypotheses. They drop two bricks, one small and the other much larger, from one of the floors of the school building.

4.2.1 Write down TWO precautions they should take to ensure that the result is reliable. (2)

4.2.2 Give a reason why, despite all the necessary precautions, they might not get the correct result. (1)

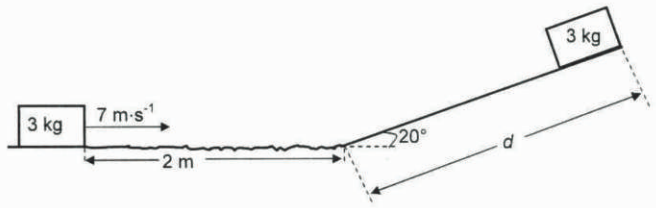
4.3 In another experiment, the learners **drop** a brick A from a height of 8 m. After 0,6 s, they **throw** a second brick B downwards from the same height. Both bricks, A and B, hit the ground at the same time.

Ignore the effects of friction and calculate the speed at which brick B was thrown. (7)
[13]

QUESTION 5 (Start on a new page.)

A 3 kg block slides at a constant velocity of 7 m·s^{-1} along a horizontal surface. It then strikes a rough surface, causing it to experience a constant frictional force of 30 N. The block slides 2 m under the influence of this frictional force before it moves up a frictionless ramp inclined at an angle of 20° to the horizontal, as shown in the diagram below.

The block moves a distance *d* up the ramp, before it comes to rest.



5.1 Show by calculation that the speed of the block at the bottom of the ramp is 3 m·s^{-1}. (5)

5.2 Draw a free-body diagram to show all the forces acting on the block in a direction parallel to the incline, whilst the block is sliding up the ramp. (2)

5.3 Calculate the distance, *d*, the block slides up the ramp. (5)
[12]

QUESTION 6 (Start on a new page.)

A man of mass 87 kg on roller skates, moving horizontally at constant speed in a straight line, sees a boy of mass 22 kg standing directly in his path. The man grabs the boy and they both continue in a straight line at 2,4 m·s^{-1}.

6.1 Calculate the man's speed just before he grabs the boy. Ignore the effects of friction. (4)

6.2 Is the collision elastic? Use a calculation to support your answer. (6)

6.3 After grabbing the boy, they both continue at a velocity of 2,4 m·s^{-1} along a straight line until they arrive at a loose gravel surface near the end of the path. They now move at constant acceleration in a straight line through the loose gravel for 2 m before coming to rest.

Calculate the magnitude of the force exerted by the gravel surface on the man and the boy. (5)
[15]

QUESTION 7 (Start on a new page.)

A fire truck, with its siren on, is moving at 20 m.s^{-1} towards a burning building. A person standing next to the road with a detector, measures the frequency of the sound emitted by the siren to be 450 Hz. The measured frequency is HIGHER than the frequency of the sound emitted by the siren.

7.1 Is the fire truck moving toward or away from the person? (1)

7.2 Explain why the registered frequency is higher. (2)

7.3 Calculate the frequency of the siren if the speed of sound in air is 340 m·s^{-1}. (4)
[7]

QUESTION 8 (Start on a new page.)

Before the Industrial Revolution, the range of colours available for art and decorative uses was limited. Pigments were harvested from natural sources such as plants, animal waste, insects and minerals.

Blue and purple, derived from a pigment in a scarce stone, came to be associated with royalty, because only the rich could afford it. Carmine, a red pigment, was produced from harvested, dried and crushed insects in Mexico. It became one of the region's most valuable export products, providing jobs for many of the local inhabitants.

However, the discovery and production of chemical pigments made clothes and paints in colours such as red, blue and purple accessible and affordable to everybody.

[Adapted from: *Wikipedia*]

8.1 Define the term *pigment*. (2)

8.2 The production of chemical pigments was beneficial to some people, but not to others. Explain this statement by referring to information from the passage. (2)

8.3 Which colour model, ADDITIVE or SUBTRACTIVE, explains the mixing of pigments? (1)

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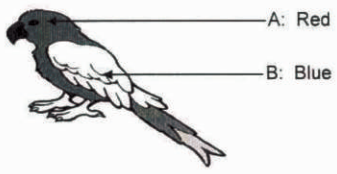
8.4 An artist has only the following three different colours of paint:

MAGENTA, YELLOW, CYAN

A picture of a parrot is to be painted in the colours shown below.



Suggest how the artist can mix the above THREE colours to paint the various parts of the parrot. Only write down the letters (A and B) and next to each the colour(s) that she must mix. (2)

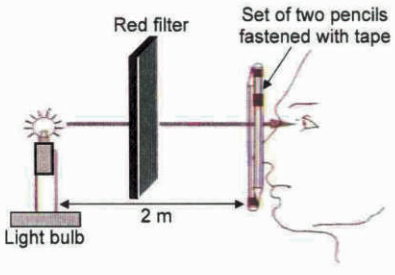
8.5 A car owner requested a panel beater to paint the door of her car the same green colour as the rest of the car. On receiving her car, she left the workshop satisfied that the colour of the paint used on the door is exactly the same as the colour of the paint used on the rest of the car. However, when she viewed the car outside in the sunlight, she observed that the door was not painted green, but cyan.

What colour of lighting was used in the workshop to have made her perceive the door as green in the workshop? Explain how you arrived at your answer. (3)
[10]

QUESTION 9 (Start on a new page.)

A learner uses a white light bulb, two pencils and a red filter to investigate a wave phenomenon.

He places the red filter in front of the light bulb and fastens the two pencils together with tape. He then observes the light bulb through the narrow gap between the two pencils from a distance of 2 m, as shown below.



9.1 Name the wave phenomenon investigated by the learner. (1)

9.2 The learner notes the following observations in his practical book:

Observation 1:
Red and dark bands of different widths are observed on either side of the central red band.

Observation 2:
When the two pencils are brought closer together, the red lines become broader.

Observation 3:
When the red filter is removed, spectral colours are observed on either side of the central band.

9.2.1 Write down Huygens's principle. (2)

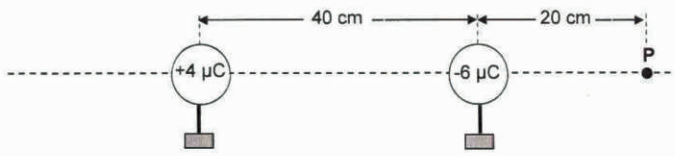
9.2.2 Use Huygens's principle to explain the occurrence of red and dark bands in Observation 1. (2)

9.2.3 Give a reason for Observation 2. (2)

9.2.4 Explain the formation of the spectral colours in Observation 3. (2)
[9]

QUESTION 10 (Start on a new page.)

Two metal spheres on insulated stands carry charges of +4 μC and -6 μC respectively. The spheres are arranged with their centres 40 cm apart, as shown below.



10.1 Calculate the magnitude of the force exerted by each sphere on the other. (4)

10.2 By what factor will the magnitude of the force in QUESTION 10.1 change if the distance between the spheres is halved? (Do not calculate the new value of the force.) (1)

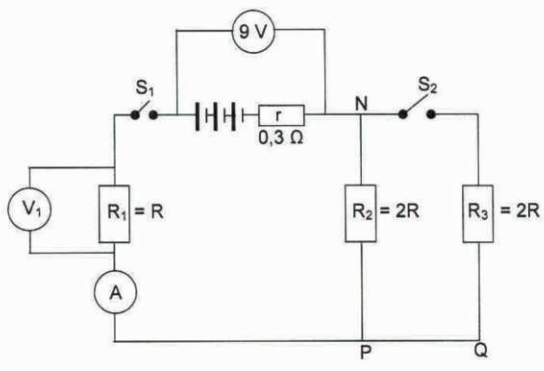
10.3 Calculate the net electric field at point P as shown in the diagram above. (6)

10.4 The spheres are now brought into contact with each other and then returned to their original positions. Now calculate the potential energy of the system of two charges. (5)
[16]

QUESTION 11 (Start on a new page.)

Three resistors, R_1, R_2 and R_3, are connected to a battery, as shown in the circuit diagram below. The internal resistance of the battery is 0,3 Ω. The resistance of R_2 and R_3 is equal. The resistance of R_1 is half that of R_2.

When both switches are open, the voltmeter across the battery reads 9 V.



11.1 What is the value of the emf of the battery? Give a reason for your answer. (2)

11.2 When **only switch S_1 is closed**, the reading on the ammeter is 3 A. Calculate the resistance of R_1. (5)

11.3 Both switches S_1 and S_2 are now closed.

11.3.1 How will the resistance of the circuit change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

11.3.2 A conducting wire of negligible resistance is connected between points Q and N. What effect will this have on the 'lost volts'? Explain the answer. (3)
[11]

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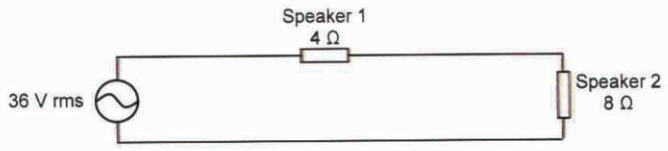
QUESTION 12 (Start on a new page.)

A source provides an rms potential difference of 36 V to a 4 Ω and an 8 Ω speaker connected in series, as shown in the diagram below.



12.1 Calculate the following:

12.1.1 rms current through the 4 Ω speaker (3)

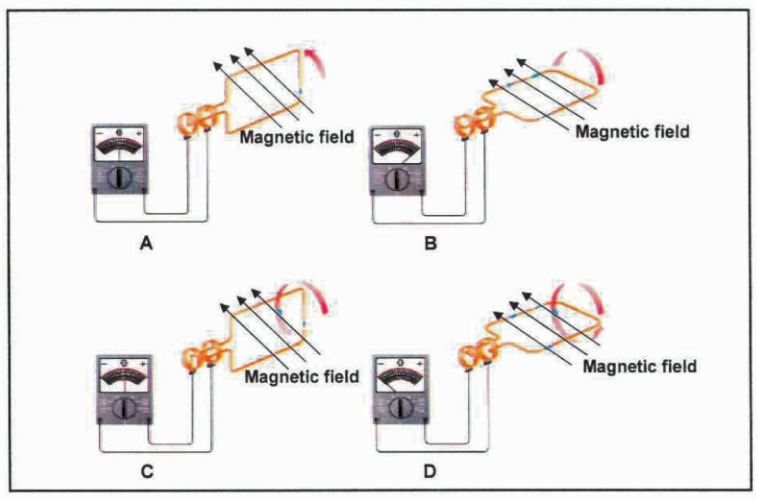
12.1.2 Peak current through each speaker (3)

12.1.3 Average power dissipated by the 4 Ω speaker (3)

12.2 Without using a calculation, state how the average power dissipated by the 4 Ω speaker compares with the power dissipated by the 8 Ω speaker. Give a reason for the answer. (3)
[12]

QUESTION 13 (Start on a new page.)

The diagrams A to D below show four positions in sequence during the anti-clockwise rotation of the coil of a simple AC generator.



13.1 Name the fundamental principle on which generators work. (1)

13.2 What is the purpose of the slip rings in an AC generator? (1)

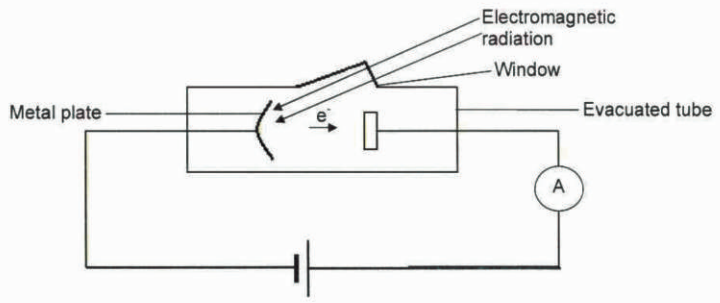
13.3 By referring to the relative positions of the coil in positions A to D, draw the corresponding graph of potential difference versus time for one full rotation (A to D to A). Indicate the positions of the coil (by using the letters A to D) on your graph. (3)

13.4 Name ONE way in which the induced emf of a specific generator can be increased. (1)

13.5 Which component in a DC generator makes it different from an AC generator? (1)
[7]

QUESTION 14 (Start on a new page.)

The diagram below shows a metal plate that emits electrons when a certain frequency of electromagnetic radiation is incident on it. The plate is connected to a source of potential difference and an ammeter as shown in the circuit below.



14.1 Name the phenomenon described above. (1)

When radiation of wavelength 555 nm is incident on the metal plate, electrons are released with zero kinetic energy.

14.2 Define the term *work function* of a metal. (2)

14.3 Calculate the work function of this metal. (6)

14.4 How will the reading on the ammeter change if the intensity of the electromagnetic radiation is increased? Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for your answer. (3)

14.5 Incident radiation with a longer wavelength is now used. How will the reading on the ammeter change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[13]

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

FORCE/*KRAG*

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

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

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

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

$v = f\lambda$ or/*of* $v = \nu\lambda$	$T = \frac{1}{f}$ or/*of* $T = \frac{1}{\nu}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\nu$ or/*of* $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$hf = W_0 + \frac{1}{2}mv^2 = hf_0 + \frac{1}{2}mv^2$

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*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

Physical Science Paper 1
November 2009
Memorandum

Learning Outcomes and Assessment Standards *Leeruitkomste en Assesseringstandaarde*		
LO1/*LU1*	**LO2/*LU2***	**LO3/*LU3***
AS12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables. *Ontwerp, beplan en voer 'n wetenskaplike ondersoek uit om data te versamel ten opsigte van akkuraatheid, betroubaarheid en die kontroleer van veranderlikes.* **AS12.1.2:** Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations. *Soek patrone en tendense, stel dit in verskillende vorms voor, verduidelik die tendense, gebruik wetenskaplike beredenering om gevolgtrekkings te maak en te evalueer, en formuleer veralgemenings.* **AS12.1.3:** Select and use appropriate problem-solving strategies to solve (unseen) problems. *Kies en gebruik geskikte probleemoplossingstrategieë om (ongesiene) probleme op te los.* **AS12.1.4:** Communicate and defend scientific arguments with clarity and precision. *Kommunikeer en verdedig wetenskaplike argumente duidelik en presies.*	**AS12.2.1:** Define, discuss and explain prescribed scientific knowledge. *Definieer, bespreek en verduidelik voorgeskrewe wetenskaplike kennis.* **AS12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in the candidate's own words. *Verduidelik en druk voorgeskrewe wetenskaplike beginsels, teorieë, modelle en wette uit deur die verwantskap tussen verskillende feite en konsepte in die kandidaat se eie woorde aan te dui.* **AS12.2.3:** Apply scientific knowledge in everyday-life contexts. *Pas wetenskaplike kennis in kontekste van die alledaagse lewe toe.*	**AS12.3.1** Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims. *Doen navorsing, bespreek, vergelyk en evalueer wetenskaplike en inheemse kennissisteme en kennisaansprake deur die ooreenkoms tussen hulle aan te dui, en verduidelik die aanvaarding van verskillende aansprake.* **AS12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications. *Vors gevallestudies na en bied etiese en morele argumente aan uit verskillende perspektiewe om die impak (voordele en nadele) van verskillende wetenskaplike en tegnologiese toepassings aan te dui.* **AS12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally. *Evalueer die impak van wetenskaplike en tegnologiese navorsing en dui die bydrae tot bestuur, benutting en ontwikkeling van bronne aan om volhoubaarheid kontinentaal en globaal te verseker.*

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 (gravitational) potential (energy) ✓
(gravitasionele) potensiële (energie) [12.2.1] (1)

1.2 watt / W ✓ [12.2.1] (1)

1.3 Coherent / coherence ✓
Koherent [12.2.1] (1)

1.4 gamma rays /*-strale* ✓

OR/*OF*
γ rays /γ*-strale* [12.2.1] (1)

1.5 Photons / *fotone* ✓

OR/*OF*
Quanta / *kwanta* [12.2.1] (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 is 9,8 m·s^{-2} at its maximum height. ✓✓
... is 9,8 m·s^{-2} by sy maksimum hoogte.

OR/*OF*
the velocity is zero at its maximum height./ *die snelheid is nul by sy maksimum hoogte.* [12.2.1] (2)

2.2 the **magnitude of the MOMENTUM** of the bullet is equal (opposite in direction) to the magnitude of the momentum of the gun. ✓✓
die **grootte van die MOMENTUM** van die *koeël is gelyk (teenoorgesteld in rigting) aan die grootte van die momentum van die geweer.*

OR/OF
...the **MOMENTUM** of the bullet is **opposite in direction** to the momentum of the gun
*... die **MOMENTUM** van die koeël is **teenoorgesteld in rigting** aan die momentum van die geweer*

OR/OF
the **MOMENTUM** of the bullet is equal to, but opposite in direction to the momentum of the gun.
*... die **MOMENTUM** van die koeël is gelyk aan, maar teenoorgesteld in rigting aan die momentum van die geweer.*

OR/*OF*
. the **CHANGE in MOMENTUM (impulse)** of the bullet is equal in magnitude (opposite in direction) to the change in momentum of the gun.
... die verandering in MOMENTUM van die koeël is gelyk in grootte (teenoorgesteld in rigting) aan die verandering in momentum van die geweer.

OR/*OF*
. the **CHANGE in MOMENTUM (impulse)** of the bullet is equal to, but opposite in direction to the change in momentum of the gun.
*... die **VERANDERING in MOMENTUM (impuls)** van die koeël is gelyk aan, maar teenoorgesteld in rigting aan die verandering in momentum van die geweer.*

OR/*OF*
... the **magnitude of the FORCE** that the bullet exerts on the gun is **equal** (opposite in direction) to the force that the gun exerts on the bullet.
*... die **grootte van die KRAG** wat die koeël op die geweer uitoefen is **gelyk** (teenoorgesteld in rigting) aan die krag wat die geweer op die koeël uitoefen.*

OR/*OF*
... the **FORCE** that the bullet exerts on the gun is **equal to, but opposite in direction** to the force that the gun exerts on the bullet.
*... die **KRAG** wat die koeël op die geweer uitoefen is **gelyk aan, maar teenoorgesteld in rigting,** aan die krag wat die geweer op die koeël uitoefen.* [12.2.3] (2)

2.3 result of diffraction / interference ✓✓
... gevolg van diffraksie / interferensie

OR/*OF*
by a triangular prism
... deur 'n driehoekige prisma ... [12.2.3] (2)

2.4 different potential differences ✓✓
... verskillende potensiaalverskille ...

OR/*OF*
Identical resistors
Identiese resistors ...

OR/OF
Identical resistors connected in parallel
Identiese resistors ...in parallel geskakel

OR/OF
Non-identical resistors .....in parallel ....different current
Nie identiese resistors ... in parallel ... verskillende stroom [12.2.2] (2)

2.5 A line absorption spectrum ✓✓
'n Lynabsorpsiespektrum ...

OR/*OF*
when electrons move from higher to lower energy levels.
... wanneer elektrone van hoër na laer energievlakke beweeg. [12.2.1] (2)
[10]

QUESTION 3/*VRAAG 3*

3.1 C ✓✓ [12.1.2] (2)

3.2 A ✓✓ [12.2.3] (2)

3.3 B ✓✓ [12.1.2] (2)

3.4 C ✓✓ [12.2.3] (2)

3.5 A ✓✓ [12.2.1] (2)
[10]

TOTAL SECTION A/*TOTAAL AFDELING A*: 25

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SECTION B/*AFDELING B*

QUESTION 4/*VRAAG 4*

4.1

Option 1/*Opsie 1*
Statements not correct (or no) / *Stellings nie reg nie (of nee)* ✓

The bricks will experience the same (gravitational) acceleration / free fall ✓ and thus reach the ground at the same time. ✓

Die bakstene ondervind dieselfde (gravitasie) versnelling /vryval ✓*en bereik dus die grond gelyktydig.* ✓

Option 2/*Opsie 2*
Pete is correct or Alex is wrong / *Pete is reg of Alex is verkeerd* ✓

The smaller brick experiences less air resistance, thus larger acceleration ✓
and reaches the ground first. ✓

Die kleiner baksteen ondervind minder lugweerstand, dus groter versnelling ✓
en tref die grond eerste. ✓

Option 3/*Opsie 3*
Alex is correct or Pete is wrong / *Alex is reg of Pete is verkeerd* ✓

In the presence of air resistance, the larger brick, with larger mass, experiences a larger net force downwards, thus largest acceleration ✓
and reaches the ground first ✓

In die aanwesigheid van lugweerstand, ondervind die groter baksteen met groter massa 'n groter netto afwaartse krag, dus grootste versnelling ✓
en *tref die grond eerste*. ✓

Option 4/*Opsie 4*
Both are correct / *Beide is reg* ✓

Pete correct: The smaller brick experiences less air resistance, thus larger acceleration and reaches the ground first. ✓
Die kleiner baksteen ondervind minder lugweerstand, dus groter versnelling en tref die grond eerste ✓

Alex correct: In the presence of air resistance, the larger brick, with larger mass, experiences a larger net force downwards, thus largest acceleration and reaches the ground first ✓
In die aanwesigheid van lugweerstand, ondervind die groter baksteen met groter massa, 'n groter netto afwaartse krag, dus grootste versnelling en tref grond eerste. ✓

[12.2.3] (3)

4.2.1 Any two / *Enige twee:*

- Ensure that both bricks are dropped from same height
  Maak seker dat beide bakstene vanaf dieselfde hoogte laat val word
- Ensure that both bricks are dropped at the same time
  Maak seker dat beide bakstene gelyktydig laat val word

  OR/*OF*
  Ensure that the stopwatch starts at instant that each brick is released and stopped at the instant that each brick reaches the ground
  Maak seker dat die stophorlosie begin die oomblik as elk van die bakstene gelos word, en gestop word die oomblik as elke baksteen die grond bereik
- Repeat the experiment several times and use the average of the results
  Herhaal die eksperiment verskeie kere en gebruik die gemiddelde van die resultate
- Make sure that $v_i = 0$ for both bricks
  Maak seker dat $v_i = 0$ *vir beide bakstene*
- Make sure that there is no strong wind
  Maak seker dat daar geen sterk wind is nie
- Use bricks made of the same material / of same density
  Gebruik bakstene gemaak van dieselfde materiaal / met dieselfde digtheid

[12.1.1] (2)

4.2.2 External force(s) may be present e.g. friction/air resistance / strong wind blowing
Eksterne krag(te) kan teenwoordig wees bv. wrywing / lugweerstand / sterk wind wat waai

[12.1.1] (1)

4.3

Option 1/*Opsie 1*:
Downward direction positive / *Afwaartse rigting positief:*
A:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
8 ✓ = $(0)\Delta t + \frac{1}{2}(9,8)\Delta t^2$ ✓
∴ $\Delta t = 1,28$ s

B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(9,8)(1,28 - 0,6)^2$ ✓
∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Downward motion negative / *Afwaartse beweging negatief:*
A:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ ✓
- 8 ✓ = $(0)\Delta t + \frac{1}{2}(-9,8)\Delta t^2$ ✓ ∴ $\Delta t = 1,28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
- 8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(-9,8)(1,28 - 0,6)^2$ ✓
∴ $v_{iB} = -8,43\ m\cdot s^{-1}$
∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Option 2/*Opsie 2*:
Downward direction positive / *Afwaartse rigting positief:*
A:
$v_f^2 = v_i^2 + 2a\Delta y$ = $0^2 + 2(9,8)(8)$ ✓ ∴ $v_f = 12,52\ m\cdot s^{-1}$
$v_f = v_i + a\Delta t$ ∴ $12,52 = 0 + (9,8)\Delta t$ ✓ ∴ $\Delta t = 1,28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(9,8)(1,28 - 0,6)^2$ ✓
∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Downward direction negative / *Afwaartse rigting negatief:*
A:
$v_f^2 = v_i^2 + 2a\Delta y$ = $0^2 + 2(-9,8)(-8)$ ✓ ∴ $v_f = -12,52\ m\cdot s^{-1}$
$v_f = v_i + a\Delta t$ ∴ $-12,52 = 0 + (-9,8)\Delta t$ ✓ ∴ $\Delta t = 1,28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
- 8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(-9,8)(1,28 - 0,6)^2$ ✓
∴ $v_{iB} = -8,43\ m\cdot s^{-1}$
∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Option 3/*Opsie 3*:
Downward direction positive / *Afwaartse rigting positief:*
A:
$v_f^2 = v_i^2 + 2a\Delta y$ = $0^2 + 2(9,8)(8)$ ✓ ∴ $v_f = 12,52\ m\cdot s^{-1}$
$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ∴ $8 = \frac{(0 + 12,52)}{2}\Delta t$ ✓ ∴ $\Delta t = 1,28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(9,8)(1,28 - 0,6)^2$ ✓
∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Downward direction negative / *Afwaartse rigting negatief:*
A:
$v_f^2 = v_i^2 + 2a\Delta y$ = $0^2 + 2(-9,8)(-8)$ ✓ ∴ $v_f = -12,52\ m\cdot s^{-1}$
$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ∴ $8 = \frac{(0 - 12,52)}{2}\Delta t$ ✓ ∴ $\Delta t = 1,28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(-9,8)(1,28 - 0,6)^2$ ✓
∴ $v_{iB} = -8,43\ m\cdot s^{-1}$
∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

Option 4/*Opsie 4*:
A:
$W_{net} = \Delta K$
$mgh = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$m(9,8)(8) = \frac{1}{2}mv_f^2 - 0$ ✓
∴ $v_f = 12,52\ m\cdot s^{-1}$ ✓

A:
$(U + K)_i = (U + K)_f$
$mgh + 0 = 0 + \frac{1}{2}mv_f^2$
$m(9,8)(8) + 0 = 0 + \frac{1}{2}mv_f^2$ ✓
∴ $v_f = 12,52\ m\cdot s^{-1}$

$v_f = v_i + a\Delta t$ ∴ $12,52 = 0 + (9,8)\Delta t$ ✓
∴ $\Delta t = 1,28$ s
B:
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
8 ✓ = $v_{iB}(1,28 - 0,6)$ ✓ + $\frac{1}{2}(9,8)(1,28 - 0,6)^2$ ✓
∴ $v_{iB} = 8,43\ m\cdot s^{-1}$ ✓ (8,43 to/*tot* 8,48 $m\cdot s^{-1}$)

[12.1.3] (7)
[13]

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QUESTION 5/*VRAAG 5*

5.1

Option 1/*Opsie 1*:
Direction of motion as positive / *Rigting van beweging as positief:*

$F_{net} = ma$ ✓
$-30 = (3)a$ ✓
$\therefore a = -10\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$= (7)^2$ ✓ $+ 2(-10)(2)$ ✓
$\therefore v_f = 3\ m\cdot s^{-1}$

Option 2/*Opsie 2*:
$W_{net} = \Delta K$ ✓ or/of ΔE_k
$F\Delta x\cos\theta$ ✓ $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(30)(2)\cos180°$ ✓ $= (\frac{1}{2}(3)v_f^2)$ ✓ $- (\frac{1}{2}(3)(7)^2)$ ✓
$-60 = 1,5v_f^2 - 73,5 \therefore v_f = 3\ m\cdot s^{-1}$

Option 3/*Opsie 3*: $W_{appl} = \Delta U + \Delta K + W_f$ 0/5
$W_{appl} = \Delta U + \Delta K - W_f$ **Max./*Maks.*:** 4/5
$0 = 0 + (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2) - (F\Delta x\cos\theta)$ ✓
$0 = 0 + \frac{1}{2}(3)v_f^2$ ✓ $- (\frac{1}{2}(3)(7)^2)$ ✓ $- (30)(2)\cos180°$ ✓
$0 = 1,5v_f^2 - 73,5 + 60 \therefore v_f = 3\ m\cdot s^{-1}$

Option 4 / *Opsie 4*: $(U + K)_i - W_f = (U + K)_f$ 0/5
$(U + K)_i + W_f = (U + K)_f$ **Max./*Maks.*:** 4/5
$(0 + \frac{1}{2}mv_i^2) + (F\Delta x\cos\theta)$ ✓ $= 0 + \frac{1}{2}mv_f^2$
$0 + \frac{1}{2}(3)(7)^2$ ✓ $+ 30(2)\cos180°$ ✓ $= 0 + \frac{1}{2}(3)v_f^2$ ✓
$73,5 - 60 = 1,5v_f^2 \therefore v_f = 3\ m\cdot s^{-1}$

Option 5 / *Opsie 5*: $(U + K)_i = (U + K)_f + W_f$ 0/5
$(U + K)_i = (U + K)_f - W_f$ **Max./*Maks.*:** 4/5
$(0 + \frac{1}{2}mv_i^2) = 0 + \frac{1}{2}mv_f^2 - (F\Delta x\cos\theta)$ ✓
$0 + \frac{1}{2}(3)(7)^2$ ✓ $= 0 + \frac{1}{2}(3)v_f^2$ ✓ $- 30(2)\cos180°$ ✓
$73,5 = 1,5v_f^2 + 60 \therefore v_f = 3\ m\cdot s^{-1}$

[12.1.3] (5)

Option 4 / *Opsie 4*:
Direction of motion as positive / *Rigting van beweging as positief:*

$F_{net} = ma$ ✓
$mg\sin20° = ma$
$-(3)(9,8)\sin20° = 3a$ ✓ $\therefore a = -3,35\ m\cdot s^{-2}$

$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0^2 = (3)^2 + 2(-3,35)(d)$ ✓

$\therefore d = 1,34$ m✓

[12.1.3] (5)
[12]

QUESTION 6 / *VRAAG 6*

6.1
$m_m v_{im} + m_b v_{bi} = (m_m + m_b)v_f$ ✓
$(87)v_{im} + 0$ ✓ $= (87 + 22)(2,4)$ ✓
$v_{im} = 3,01\ m\cdot s^{-1}$ ✓ [12.2.3] (4)

6.2

Option 1/*Opsie 1*:
K(before/*voor*) $= \frac{1}{2}mv^2$ ✓
$= \frac{1}{2}(87)(3,01)^2 + 0$ ✓
$= 394,11$ J ✓
$= (391,5$ if 3 $m\cdot s^{-1})$

K(after/*na*) $= \frac{1}{2}mv^2$
$= \frac{1}{2}(109)(2,4)^2$ ✓
$= 313,92$ J ✓

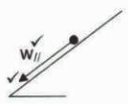
Collision is inelastic / No ✓
Botsing is nie-elasties / Nee

Option 2/*Opsie 2*:
ΔK = K(after/*na*) - K(before/*voor*)
$= \frac{1}{2}mv^2$(after/*na*) $- \frac{1}{2}mv^2$(before/*voor*) ✓
$= \frac{1}{2}(109)(2,4)^2$✓ $- (\frac{1}{2}(87)(3,01)^2 + 0)$ ✓
$= 313,92 - 394,11$
$= -80,19$ J ✓✓

Collision is inelastic / No ✓
Botsing is nie-elasties / Nee

[12.2.3] (6)

5.2



Any one of the following labels / *Enige een van volgende benoemings:*
- $w_{parallel}$ or/of $w_{//}$
- $F_{g(parallel)}$ or/of $F_{g//}$
- mgsin20°
- Component of weight parallel to incline / *komponent van gewig parallel aan skuinste*

Checklist / *kontrolelys* Free-body diagram / *vrye kragtediagram*	
Direction of force indicated as parallel to and down incline (not needed to show incline) *Rigting van krag getoon as parallel aan en afwaarts teen skuinste (skuinste hoef nie getoon te word nie)*	✓
Correct label / korrekte benoeming	✓

[12.1.2] (2)

5.3

Option 1/*Opsie 1*:
$(U + K)_i = (U + K)_f$ ✓
$0 + \frac{1}{2}mv_i^2 = mgh + 0$
$0 + \frac{1}{2}(3)(3)^2$ ✓ $= (3)(9,8)h + 0$ ✓
$\therefore h = 0,46$ m

$\sin20° = \frac{h}{d}$ ✓ $= \frac{0,46}{d} \therefore d = 1,34$ m ✓

As single step/*As een stap:*
$(U + K)_i = (U + K)_f$ ✓
$0 + \frac{1}{2}(3)(3)^2$ ✓ $= (3)(9,8)h + 0$ ✓
$\frac{1}{2}(3)(3)^2 = (3)(9,8)d\sin20°$ ✓
$\therefore d = 1,34$ m ✓

Option 2/*Opsie 2*:
$W_{net} = \Delta K$ ✓ (or/*of* ΔEk)
$F_{g//}\Delta x\cos\theta = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(3)(9,8)\sin20°$ ✓ $(d)\cos180°$ ✓ $= 0 - \frac{1}{2}(3)(3)^2$ ✓
$-10,06d = -13,5 \therefore d = 1,34$ m ✓

Option 3/*Opsie 3*:
$W_{net} = \Delta K$ ✓ (or/*of* ΔEk)
$W_{gravity} = K_f - K_i$
$mgh\cos180°$ ✓ $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$(3)(9,8)h(-1)$ ✓ $= 0 - \frac{1}{2}(3)(3)^2$ ✓ $\therefore h = 0,46$ m

$\sin20° = \frac{h}{d}$ ✓$= \frac{0,46}{d} \therefore d = 1,34$ m ✓

6.3

Option 1 / *Opsie 1*:
$W_{net} = \Delta E_k$ ✓
$F_{net}\Delta x\cos\theta$ ✓ $= \frac{1}{2}m(v_f^2 - v_i^2)$
$F_{net}(2)(-1)$ ✓ $= \frac{1}{2}(87 + 22)(0^2 - 2,4^2)$ ✓
$\therefore F_{net} = 156,96$ N ✓
If/*indien* – 156,96 N: minus 1

Option 2 / *Opsie 2*:
$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0^2 = 2,4^2 + 2a(2)$ ✓ $\therefore a = -1,44\ m\cdot s^{-2}$

$F_{net} = ma$ ✓ $= (87 + 22)(-1,44)$ ✓ $= -156,96$ N
$\therefore F_{net} = 156,96$ N ✓

Option 3 / *Opsie 3*:
$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $\therefore 2 = (\frac{0+2,4}{2})\Delta t$ ✓ $\therefore \Delta t = 1,67$ s
$F_{net}\Delta t = \Delta p = mv_f - mv_i$ ✓
$F_{net}(1,67) = (87 + 22)(0 - 2,4)$ ✓
$\therefore F_{net} = -156,65$ N $\therefore F_{net} = 156,65$ N ✓

Option 4 / *Opsie 4*:
$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ ✓ $\therefore 2 = (\frac{0+2,4}{2})\Delta t$ ✓ $\therefore \Delta t = 1,67$ s
$v_f = v_i + a\Delta t \therefore 0 = 2,4 + a(1,67) \therefore a = -1,44\ m\cdot s^{-2}$
$F_{net} = ma$ ✓ $= (87 + 22)(-1,44)$ ✓ $= -156,96$ N
$\therefore F_{net} = 156,96$ N ✓

[12.2.3] (5)
[15]

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QUESTION 7/*VRAAG 7*

7.1 Towards the person / *Na die persoon toe* ✓ [12.1.2] (1)

7.2 When the source moves towards a stationary observer
waves in front of the source is compressed ✓
resulting in a shorter wavelength ✓, resulting in a higher frequency
(speed of sound constant)

Wanneer die bron 'n stilstaande waarnemer nader,
word golwe voor die bron saamgepers ✓
wat 'n korter golflengte tot gevolg het ✓ *wat 'n hoër frekwensie tot gevolg het (spoed van klank konstant)* [12.2.2] (2)

7.3 Formulae accepted / *Formules aanvaar:*

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

$\therefore 450$ ✓$= (\frac{340}{340 \checkmark 20}) f_s$ [12.2.3] (4)

$\therefore f_s = 423{,}53$ Hz ✓ **[7]**

QUESTION 8/*VRAAG 8*

8.1 A (chemical) substance that (selectively) absorb light of certain frequencies / colours and (selectively) transmits / reflects others. ✓✓

'n (Chemiese) stof wat (selektief) lig van sekere frekwensies / kleure absorbeer en ander (selektief) deurlaat / weerkaats. [12.2.1] (2)

8.2 The manufacturing of pigments made all colours affordable for all people./ *Vervaardiging van pigmente het alle kleure vir alle mense bekostigbaar gemaak.* ✓

At the same time people, e.g. the Mexicans, could have lost their jobs and only income. / *Terselfdertyd het mense, bv. die Meksikane, hulle werk en enigste inkomste verloor.* ✓ [12.3.1] (2)

8.3 Subtractive / *Subtraktief* ✓ [12.2.1] (1)

8.4 A: magenta + yellow / *geel* ✓
B: magenta + cyan / *siaan* ✓ [12.2.3] (2)

 Please turn over/*Blaai om asseblief*

8.5 **Option 1/*Opsie 1:***
Yellow light / *Geel lig* ✓

Cyan paint reflects blue and green light ✓
(Yellow light contains green light and red light)
Only green light (in yellow light) will be reflected ✓and it appears green

Siaanverf weerkaats blou en groen lig ✓
(Geel lig bevat groen en rooi lig)
Slegs groen lig (in geel lig) sal weerkaats word ✓*en dit kom groen voor*

Option 2/*Opsie 2:*
Green light / *Groen lig* ✓

Cyan paint reflects blue and green light ✓
When green light shines onto it, only green light will be reflected ✓and it appears green

Siaanverf weerkaats blou en groen lig ✓
Wanneer groen lig daarop skyn, word slegs groen lig weerkaats ✓*en dit kom groen voor.* [12.2.3] (3)
[10]

QUESTION 9 / *VRAAG 9*

9.1 Diffraction / *Diffraksie* ✓ [12.1.2] (1)

9.2.1 Each point on a wave front acts as a source of (spherical) secondary wave fronts / wavelets (that propagates in the forward direction). ✓✓
Elke punt op 'n golffront dien as 'n bron van (sferiese) sekondêre golffronte / golfies (wat in 'n voorwaartse rigting voortplant). [12.2.1] (2)

9.2.2 Dark bands form where **wave fronts / wavelets** interfere destructively.✓
Red/bright bands form where **wave fronts / wavelets** interfere constructively. ✓

*Donker bande vorm waar **golffronte / golwe** destruktiewe interferensie ondergaan.* ✓
*Rooi/helder bande vorm waar **golffronte / golwe** konstruktiewe interferensie ondergaan.* ✓ [12.1.4] (2)

 Please turn over/*Blaai om asseblief*

9.2.3 Diffraction is inversely proportional to the slit width / Diffraction $\alpha \frac{1}{a}$ ✓✓
Diffraksie is omgekeerd eweredig aan die spleetwydte /
Diffraksie $\alpha \frac{1}{a}$ ✓✓

OR/*OF*
The degree of diffraction / Angle at which minima occurs increases with decreasing slit width
Mate van diffraksie / Hoek waar minima voorkom neem toe met afname in spleetwydte [12.1.4] (2)

9.2.4 *White light* consists of different colours with different wavelengths ✓
Amount of diffraction differs for different colours / different wavelengths. ✓

Wit lig bestaan uit verskillende kleure met verskillende golflengtes. ✓
Mate van diffraksie verskil vir verskillende kleure / golflengtes. ✓ [12.1.4] (2)
[9]

QUESTION 10 / *VRAAG 10*

10.1 $F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(4\times10^{-6})(6\times10^{-6})}{(0{,}4)^2}$ ✓ ✓

$F = 1{,}35$ N ✓

OR/*OF*

$F = \frac{kQ_1Q_2}{r^2}$ ✓

$F = \frac{(9\times10^9)(4\times10^{-6})(-6\times10^{-6})}{(0{,}4)^2}$ ✓

$F = -1{,}35$ N
Magnitude of / *Grootte van* F = 1,35 N ✓ [12.2.3] (4)

10.2 four / *vier (4)* ✓ [12.2.2] (1)

 Please turn over/*Blaai om asseblief*

10.3 $E(6\ \mu C) = \frac{kQ}{r^2}$ ✓

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

$= 1{,}35 \times 10^6\ N\cdot C^{-1}$ to the left/*na links*

$E(4\ \mu C) = \frac{kQ}{r^2}$

$= \frac{(9\times10^9)(4\times10^{-6})}{(0{,}6)^2}$ ✓ ✓

$= 1 \times 10^5\ N\cdot C^{-1}$ (to the right / *na regs*)
To the right as positive/*Na regs as positief:*
$E_{net/netto} = -1{,}35 \times 10^6 + 1 \times 10^5 = -1{,}25 \times 10^6\ N\cdot C^{-1}$ ✓

$E_{net/netto} = 1{,}25 \times 10^6\ N\cdot C^{-1}$ to the left / *na links* ✓

OR/*OF*

$E_{net} = \frac{kQ}{r^2}$ ✓ $= 9 \times 10^9 (\frac{-6\times10^{-6}}{(0{,}2)^2} + \frac{(4\times10^{-6})}{(0{,}6)^2})$ ✓ ✓

$= -1{,}35 \times 10^6 + 1 \times 10^5 = -1{,}25 \times 10^6$

$E_{net/netto} = 1{,}25 \times 10^6\ N\cdot C^{-1}$ in the direction of the field of the 6 μC charge/*in die rigting van veld van die 6 μC lading* ✓ [12.1.3] (6)

10.4 New charge/*Nuwe lading* $= \frac{(+4\times10^{-6}) + (-6\times10^{-6})}{2}$ ✓

$= -1 \times 10^{-6}$ C or/*of* $-1\ \mu C$

$U = \frac{kQ_1Q_2}{r}$ ✓

$= \frac{(9\times10^9)(-1\times10^{-6})(-1\times10^{-6})}{(0{,}4)}$ ✓

$\therefore U = 2{,}25 \times 10^{-2}$ J ✓ (0,02 J) [12.1.3] (5)
[16]

QUESTION 11 / *VRAAG 11*

11.1 9 V ✓
Potential difference measured when:
switch is open / no current flows / circuit is open/no work done is in external circuit ✓
Potensiaalverskil gemeet wanneer:
die skakelaar oop is / geen stroom vloei nie / stroombaan oop is / geen arbeid verrig word in die eksterne stroombaan nie [12.2.2] (2)

 Please turn over/*Blaai om asseblief*

11.2

Option 1 / *Opsie 1*:

Emf = IR + Ir ✓
9 ✓= 3(3R) ✓ + 3(0,3) ✓

$\therefore R = R_1 = \frac{9-0,9}{9} = 0,9\ \Omega$ ✓

Option 2 / *Opsie 2*:

Emf = IR + Ir ✓
9 ✓= V_{ext} + (3)(0,3) ✓ ∴ V_{ext} = 8,1 V

$V_{ext} = I(R_1 + R_2)$
8,1 = 3(3R) ✓ ∴ R_1 = 0,9 Ω ✓

Option 3 / *Opsie 3*:

emf = IR + Ir ✓
9 ✓= V_{ext} + (3)(0,3) ✓ ∴ V_{ext} = 8,1 V

$\therefore V_1 = \frac{8,1}{3} = 2,7$ V $\quad (R_1 + R_2 = 3R)$

$R_1 = \frac{V_1}{I} = \frac{2,7}{3✓} = 0,9\ \Omega$ ✓

Option 4 / *Opsie 4*:

$R_t = \frac{V}{I}✓ = \frac{9}{3}✓ = 3\ \Omega$

$R_2 + R_1 = 3 - 0,3$ ✓ = 2,7 Ω = 3R

$\therefore R_1 = R = \frac{2,7}{3✓} = 0,9\ \Omega$ ✓

Option 5 / *Opsie 5*:

V_{int} = Ir ✓ = (3)(0,3) ✓ = 0,9 V

V_{ext} = 9✓ – 0,9 = = 8,1 V

$V_1 = IR_1 \therefore V_1 = 3R$
$V_{R2} = IR_2 \therefore V_{R2} = 3(2R) = 6R$

$V_1 + V_{R2} = 3R + 6R = 9R$
∴ 8,1 = 9R ✓ ∴ R = 0,9 Ω ✓

[12.1.3] (5)

11.3.1 Decreases / *Verminder* ✓ [12.2.2] (1)

11.3.2 Increases / *Vermeerder* ✓
Resistance decreases / *Weerstand verminder* ✓
Current increases / *Stroom vermeerder* ✓
Ir increases / *Ir vermeerder*

OR/*OF*
Increases / *Vermeerder* ✓
Current passes through wire QN / wire QN shorts the parallel combination of resistors R_2 and R_3 ✓
All the current passes through R_1 and also through battery, thus Ir increases ✓
Die stroom gaan deur draad QN / draad QN veroorsaak 'n kortsluiting van die parallelle kombinasie resistors R_2 en R_3
Al die stroom gaan deur R_1 en deur die battery, dus verhoog Ir [12.2.2] (3)
[11]

QUESTION 12/*VRAAG 12*

12.1.1 $I_{rms} = \frac{V_{rms}}{R}✓ = \frac{36}{12}✓ = 3$ A✓

OR/*OF*
$V_{4\Omega} + V_{8\Omega}$ = 36 V and/en $V_{4\Omega}:V_{8\Omega}$ = 1:2
∴ $V_{4\Omega}$ = 12 V
$I_{4\Omega} = \frac{V}{R}✓ = \frac{12}{4}✓ = 3$ A ✓ [12.2..3] (3)

12.1.2 $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ ✓
$\therefore 3 = \frac{I_{max}}{\sqrt{2}}$ ✓ $\therefore I_{max}$ = 4,24 A ✓ [12.2.3] (3)

12.1.3 $P_{ave} = I^2_{rms}R$ ✓ = $(3)^2(4)$ ✓ = 36 W✓

OR/*OF*
V_{rms} (speaker/luidspreker 1) = $I_{rms}R$ = (3)(4) = 12 V
$P_{ave} = V_{rms}I_{rms}$ ✓ = (12)(3) ✓ = 36 W ✓

OR/*OF*
V_{rms} (speaker/luidspreker 1) = $I_{rms}R$ = (3)(4) = 12 V
$P_{ave} = \frac{V^2_{rms}}{R}✓ = \frac{12^2}{4}✓$ = 36 W ✓ [12.2.3] (3)

12.2 $P_{4\Omega} = ½ P_8$ or $P_{8\Omega} = 2 P_{4\Omega}$ or /*of*
Smaller / *Kleiner* ✓($P_{4\Omega} < P_{8\Omega}$) or/*of* $P_{8\Omega} > P_{4\Omega}$)

$P_{ave} = I^2_{rms}R$, but since
I_{rms} is constant / *omdat I_{wgk} konstant is*✓
P α R ✓

OR/*OF*
$P_{4\Omega} = ½ P_8$ or $P_{8\Omega} = 2 P_{4\Omega}$ or /*of*
Smaller / *Kleiner* ✓

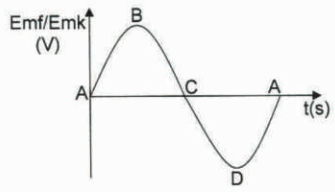
$P_{ave} = V_{rms}I_{rms}$, since
I_{rms} is constant / *omdat I_{wgk} konstant is* ✓
P_{ave} α V ✓ [12.2.2] (3)
[12]

QUESTION 13 / *VRAAG 13*

13.1 Electromagnetic induction / Faraday's law ✓
Elektromagnetiese induksie / Faraday se wet [12.2.1] (1)

13.2 Provides a (sliding) contact (between coil and conducting wires) ✓/ Ensures free rotation
Verskaf 'n (glyende) kontak (tussen die spoel en die geleidende drade)/ Verseker dat spoel vrylik roteer [12.2.1] (1)

13.3



Checklist / *Kontrolelys* Criteria for graph / *Kriteria vir grafiek*	Marks/ *Punte*
Correct shape **with full cycle (ignore if more than one cycle shown** / *Korrekte vorm **met volle siklus (ignoreer indien meer as een siklus getoon word)***	✓✓
Points A, B, C and D correctly indicated/Punte A, B, C en D korrek aangedui,	✓

[12.1.2] (3)

13.4 Increase the speed at which the coil rotates ✓
Verhoog die spoed waarteen die spoel roteer [12.2.3] (1)

13.5 (Splitring) commutator ✓
(Splitring)kommutator [12.2.3] (1)
[7]

QUESTION 14/*VRAAG 14*

14.1 Photoelectric effect / *Foto-elektriese effek* ✓ [12.2.1] (1)

14.2 The minimum energy of light needed to emit (photo)electrons from a metal ✓✓
Die minimum energie benodig deur lig om (foto-)elektrone uit 'n metaal vry te stel [12.2.1] (2)

14.3

Option 1 / *Opsie 1*:

$E/hf = \frac{hc}{\lambda}✓ = \frac{(6,63\times10^{-34}✓)(3\times10^8)}{555\times10^{-9}✓} = 3,58 \times 10^{-19}$ J

$hf = W_0 + \frac{1}{2}mv^2$ ✓ ∴ $3,58 \times 10^{-19} = W_0 + 0$ ✓
∴ $W_0 = 3,58 \times 10^{-19}$ J ✓

Option 2 / *Opsie 2*:

$hf = W_0 + \frac{1}{2}mv^2$ ✓

$\frac{hc}{\lambda}$ ✓= $W_0 + \frac{1}{2}mv^2$

$\frac{(6,63\times10^{-34}✓)(3\times10^8)}{555\times10^{-9}✓} = W_0 + 0$ ✓
∴ $W_0 = 3,58 \times 10^{-19}$ J ✓

Option 3 / *Opsie 3*:

$f = \frac{c}{\lambda} = \frac{3\times10^8}{555\times10^{-9}}✓ = 5,41 \times 10^{14}$ Hz

$E = hf = (6,63 \times 10^{-34})(5,41 \times 10^{14})$ ✓= $3,59 \times 10^{-19}$ J

$hf = W_0 + \frac{1}{2}mv^2$ ✓ ∴ $3,59 \times 10^{-19} = W_0 + 0$ ✓
∴ $W_0 = 3,59 \times 10^{-19}$ J ✓

Option 4 / *Opsie 4*:

$W_0 = hf_0$ ✓✓ $= \frac{(6,63\times10^{-34}✓)(3\times10^8)}{555\times10^{-9}✓}$ ✓ = $3,58 \times 10^{-19}$ J ✓

[12.1.3] (6)

14.4 Increases / *Vermeerder* ✓

With light of higher intensity more photons strikes the metal surface per second / *Met lig van hoër intensiteit tref meer fotone die metaaloppervlak per sekonde* ✓

Thus more (photo)electrons are emitted per second, ✓resulting in a bigger current./ *Dus word meer (foto-)elektrone per sekonde vrygestel wat 'n hoër stroom tot gevolg het.* [12.2.2] (3)

14.5 Decreases / *Verminder* ✓ [12.2.2] (1)
[13]

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

Physical Sciences: Chemistry P2
February/March 2009
Memorandum

Learning Outcomes and Assessment Standards *Leeruitkomste en Assesseringstandaarde*		
LO 1/*LU 1*	**LO 2/*LU 2***	**LO 3/*LU 3***
AS 12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables. *Ontwerp, beplan en voer 'n wetenskaplike ondersoek uit om data te versamel ten opsigte van akkuraatheid, betroubaarheid en die kontroleer van veranderlikes.* **AS 12.1.2:** Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations. *Soek patrone en tendense, stel dit in verskillende vorms voor, verduidelik tendense, gebruik wetenskaplike beredenering om gevolgtrekkings te maak en te evalueer, en formuleer veralgemenings.* **AS 12.1.3:** Select and use appropriate problem-solving strategies to solve (unseen) problems. *Kies en gebruik geskikte probleemoplossingstrategieë om (ongesiene) probleme op te los.* **AS 12.1.4:** Communicate and defend scientific arguments with clarity and precision. *Kommunikeer en verdedig wetenskaplike argumente duidelik en presies.*	**AS 12.2.1:** Define, discuss and explain prescribed scientific knowledge. *Definieer, bespreek en verduidelik voorgeskrewe wetenskaplike kennis.* **AS 12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in own words. *Verduidelik en druk voorgeskrewe wetenskaplike beginsels, teorieë, modelle en wette uit deur die verwantskap tussen verskillende feite konsepte in eie woorde aan te dui.* **AS 12.2.3:** Apply scientific knowledge in everyday life contexts. *Pas wetenskaplike kennis in kontekste van die alledaagse lewe toe.*	**AS 12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications. *Vors gevallestudies na en lewer etiese en morele argumente uit verskillende perspektiewe om die impak (voordele en nadele) van verskillende wetenskaplike en tegnologiese toepassings aan te dui.* **AS 12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally. *Evalueer die impak van wetenskaplike en tegnologiese navorsing en dui die bydrae tot die bestuur, benutting en ontwikkeling van bronne om volhoubaarheid kontinentaal en globaal te verseker, aan.*

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 Functional group / ✓
Funksionele groep [12.2.1] (1)

1.2 (Primary) amines ✓
(Primêre) amiene [12.2.1] (1)

1.3 Activation energy ✓
Aktiveringsenergie [12.2.1] (1)

1.4 Electrolytic ✓
Elektrolities [12.2.1] (1)

1.5 Chlorine / $C\ell_2$ ✓
Chloor / $C\ell_2$ [12.2.1] (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 G (C_2H_5OH) ✓ [12.2.1] (1)

2.2 I ($C_6H_5(CH_3)$) ✓ [12.2.3] (1)

2.3 B (reaction rate / *reaksietempo*) ✓ [12.2.3] (1)

2.4 J (anode) ✓ [12.2.1] (1)

2.5 D (Na^+) ✓ [12.2.1] (1)
[5]

QUESTION 3/*VRAAG 3*

3.1 True / *Waar* ✓✓ [12.2.1] (2)

3.2 True / *Waar* ✓✓ [12.2.1] (2)

3.3 True / *Waar* ✓✓ [12.2.3] (2)

3.4 False / *Onwaar* ✓
A temperature of 298 K (25 °C) / *'n Temperatuur van 298 K (25 °C)* ✓ [12.2.1] (2)

3.5 False / *Onwaar* ✓
Secondary cell / *Sekondêre sel* ✓
OR / *OF*
is non-rechargeable / *is nie-herlaaibaar* [12.2.1] (2)
[10]

QUESTION 4/*VRAAG 4*

4.1 C ✓✓✓ [12.2.3] (3)

4.2 C ✓✓✓ [12.1.2] (3)

4.3 A ✓✓✓ [12.1.2] (3)

4.4 B ✓✓✓ [12.3.2] (3)

4.5 D ✓✓✓ [12.3.3] (3)
[15]

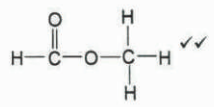
TOTAL SECTION A: 35
TOTAAL AFDELING A: 35

SECTION B/*AFDELING B*

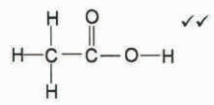
QUESTION 5/*VRAAG 5*

5.1 Compounds that have the same molecular formula but different structural formulae. ✓✓
Verbindings wat dieselfde molekulêre formule maar verskillende struktuurformules het. [12.2.1] (2)

5.2



✓✓ methylmethanoate ✓
metielmetanoaat



✓✓ ethanoic acid ✓
etanoësuur
[12.2.3] (6)

5.3.1 Ethanoic acid / *etanoësuur* ✓
- The hydrogen bonds/intermolecular forces between ethanoic acid molecules are <u>stronger</u> than the Van der Waals forces/intermolecular forces✓ between the ester molecules / *Die waterstofbindings/intermolekulêre kragte tussen etanoësuur-molekule is <u>sterker</u> as die Van der Waalskragte/intermolekulêre kragte tussen die estermolekule.*
- <u>More energy</u> needed to break bonds between ethanoic acid molecules. ✓ / *<u>Meer energie</u> word benodig om bindings tussen etanoësuurmolekule te breek.* [12.2.3] (3)

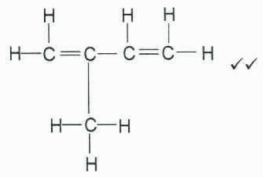
5.3.2 Methylmethanoate / *metielmetanoaat* ✓
- The Van der Waals forces/intermolecular forces ✓ between the ester molecules are <u>weaker</u> than the hydrogen bonds/ intermolecular forces between ethanoic acid molecules / *Die Van der Waalskragte/intermolekulêre kragte tussen die estermolekule is <u>swakker</u> as die waterstofbinding/ intermolekulêre kragte tussen die etanoësuurmolekule.*
- <u>Less energy needed</u> to break bonds between the <u>ester molecules</u>. ✓ / *<u>Minder energie</u> word benodig om bindings tussen die estermolekule te breek.* [12.2.3] (3)

5.4 Decrease / *Afneem* ✓
Van der Waals forces increase with molecular size ✓✓ / *Van der Waalskragte neem met molekulêre grootte toe* [12.2.2] (3)
[17]

QUESTION 6/*VRAAG 6*

6.1 Unsaturated/*Onversadig* ✓
Not all C-C bonds are single bonds/*Nie alle C-C bindings is enkele bindings nie* ✓✓
OR/*OF*
Contains C-C double bonds/*Bevat dubbele bindings C-C* [12.2.3] (3)

6.2



✓✓

[12.2.3] (2)

6.3 Any TWO:
- Destruction of indigenous forests ✓ (leading to global warming)
- Rubber is not biodegradable ✓ – disposal impacts negatively on environment
- Burning of rubber releases toxic gases

Enige TWEE:
- *Verwoesting van inheemse woude (lei tot aardverwarming)*
- *Rubber is nie-bioafbreekbaar nie – wegdoening daarmee het negatiewe impak op omgewing*
- *Brand van rubber skei giftige gasse af* [12.3.3] (2)

6.4 Any TWO:
- Job creation ✓
- Tyres for cars/gloves for medical industry/raincoats etc. ✓
- Protective devices – insulation

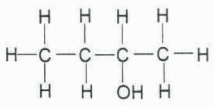
Enige TWEE:
- *Werkskepping*
- *Bande vir motors/handskoene vir mediese industrie/reënjasse, ens.*
- *Beskermende toestelle - insulasie* [12.3.2] (2)
[9]

QUESTION 7/*VRAAG 7*

7.1 III - elimination/dehydration ✓
eliminasie/dehidrasie [12.1.2] (1)

7.2 I – hydration / *hidrasie* ✓
II – hydrohalogenation / *hidrohalogenering* ✓ [12.1.2] (2)

7.3

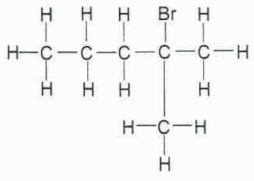


✓✓

2 butanol/butan–2 ol ✓ [12.2.3] (3)

7.4 H_2SO_4 ✓ [12.2.1] (1)

7.5



✓✓

2-bromo-2-methylpentane ✓
2-bromo-2-metielpentaan/2-broom-2-metielpentaan [12.2.3] (3)

7.6 Alkenes/*alkene* ✓✓ [12.2.3] (2)
[12]

QUESTION 8/*VRAAG 8*

8.1 Neutralisation/acid-base reaction ✓
Neutralisasie/suur-basisreaksie [12.3.2] (1)

8.2.1 What is the relationship between temperature and the reaction rate of an antacid tablet with water? ✓✓
Wat is die verwantskap tussen temperatuur en reaksietempo van 'n teensuurtablet met water?
OR/*OF*
What happens with the reaction rate of the antacid tablet with water when the temperature changes (increases) (decreases)?
Wat gebeur met die reaksietempo van die teensuurtablet met water wanneer die temperatuur verander (toeneem) (afneem)?
OR/*OF*
How does temperature influence the time of dissolution of an antacid tablet in water?
Hoe beïnvloed temperatuur die oplossingstyd van 'n teensuurtablet in water? [12.1.1] (2)

8.2.2 The reaction rate (of an antacid tablet with water) will increase/decrease with increase/decrease in temperature. ✓✓
Die reaksietempo (van 'n teensuurtablet met water) sal toeneem/afneem met toename/afname in temperatuur.
OR/*OF*
The higher/lower the temperature the faster/slower the rate of dissolution/reaction.
Hoe hoër/laer die temperatuur hoe vinniger/stadiger is die tempo van oplossing/reaksie. [12.1.1] (2)

8.2.3
1. Use the measuring cylinder and measure a fixed volume of water and transfer it to the beaker.
Gebruik die maatsilinder en meet 'n vaste volume water af en dra dit oor na die beker.
2. Record the temperature of the water.
Noteer die temperatuur van die water.
3. Add one antacid tablet to the water and measure the time it takes to dissolve/react completely.
Voeg een teensuurtablet by die water en meet die tyd wat dit neem om volledig op te los/te reageer.
4. Rinse the solution down the sink and repeat the experiment at at least two more different temperatures.
Spoel die oplossing in die wasbak af en herhaal die eksperiment by ten minste nog twee verskillende temperature.
5. Repeat steps 1 to 4 for accuracy/compensate for experimental error.

Herhaal stappe 1 tot 4 vir akkuraatheid/kompenseer vir eksperimentele foute.

Checklist/*Kontrolelys* Criteria for procedure/*Kriteria vir prosedure:*	Marks/ *Punte*
Measurement of fixed volume of water with measuring cylinder and transfer of water to beaker. / *Afmeting van vaste volume water met maatsilinder en die oordrag van water na beker.*	✓
Temperature of water taken with thermometer. *Neem van temperatuur van water met termometer.*	✓
Antacid tablet added to water and time taken to completely dissolve. *Teensuurtablet by water gevoeg e nnotering van tyd om volledig op te los.*	✓
Experiment repeated at two other temperatures. *Eksperiment word by twee ander temperature herhaal.*	✓

[12.1.1] (4)

8.2.4

Temperature / *Temperatuur* (°C)	Time/*Tyd* (s)		Average time/*Gemiddelde tyd* (s)
	Trial/*Lopie* 1	Trial/*Lopie* 2	

Checklist/*Kontrolelys* Criteria for table/*Kriteria vir tabel:*	Marks/ *Punte*
Temperature and unit as column/row heading *Temperatuur en eenheid as kolom/ry-opskrif*	✓
Time and unit as column or row heading *Tyd en eenheid as kolom/ry-opskrif*	✓
Table indicates at least two trials *Tabel toon ten minste twee lopies*	✓
Column/row for average time and unit *Kolom/ry vir gemiddelde tyd en eenheid*	✓

[12.1.2] (4)

8.3 Warm water / *Warm water* ✓
- The rate at which it will bring relieve will be faster at a higher temperature / *Die tempo waarteen dit verligting bring, sal vinniger by 'n hoër temperatuur wees*✓ [12.3.2] (2)
[15]

Physical Sciences: Chemistry P2
February/March 2009
Memorandum

QUESTION 9/*VRAAG 9*

9.1 During exercise more air is breathed ✓and more toxic ozone/nitrogen dioxide will be inhaled, resulting in lung problems/poor performance due to oxygen deficiency. ✓
Gedurende oefening word meer lug ingeasem en dus meer giftige osoon/stikstofdioksied wat lei tot longprobleme / swak prestasie a.g.v. suurstoftekort. [12.3.2] (2)

9.2
- Supply more and safe public transport to decrease cars on road. ✓
  Verskaf meer en veilige openbare vervoer om motors op paaie te verminder.
- Make catalytic converters compulsory in exhaust systems of cars ✓
  Maak katalitiese omskakelaars in motoruitlaatstelsels verpligtend [12.3.2] [12.3.3] (2)

9.3 The high temperature will favour the forward ✓ endothermic reaction ✓and more NO(g) is formed.
Die hoë temperatuur bevoordeel die voorwaartse endotermiese reaksie en meer NO(g) word gevorm. [12.1.2] (2)

9.4

	N_2	O_2	NO	
Molar ratio/*Molverhouding*	1	1	2	
Initial quantity (mol)/ *Aanvangshoeveelheid (mol)*	1	1	0 ✓	
Change (mol)/ *Verandering (mol)*	0,1	0,1	0,2	✓
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig(mol)*	0,9	0,9	0,2	✓
Concentration ($mol \cdot dm^{-3}$) *Konsentrasie ($mol \cdot dm^{-3}$)*	0,45	0,45	0,1	✓

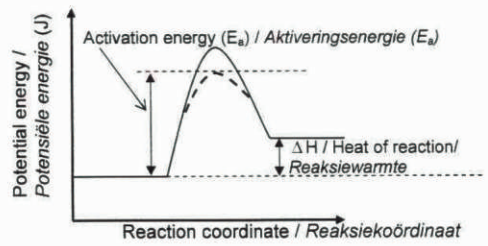
$$K_c = \frac{[NO]^2}{[N_2][O_2]} \checkmark = \frac{(0,1)^2}{(0,45)(0,45)} \checkmark = 0,049 = 0,05 \checkmark$$

[12.1.3] (7)

9.5 9.5.1 No effect / *geen effek* ✓✓ [12.2.3] (2)

9.5.2 No effect / *geen effek* ✓ [12.2.3] (1)

9.6



Checklist/*Kontrolelys* Criteria for diagram/ *Kriteria vir diagram*	Marks/ *Punte*
Both axes drawn and correctly labelled. *Beide asse geteken en korrek benoem.*	✓
Shape of graph drawn correctly. *Vorm van grafiek korrek geteken.*	✓
Activation energy correctly indicated. *Aktiveringsenergie korrek aangetoon.*	✓
Heat of reaction correctly indicated. *Reaksiewarmte korrek aangetoon.*	✓
Path with catalyst correctly indicated *Pad met katalisator korrek aangetoon.*	✓

[12.1.2] (5)
[21]

QUESTION 10/*VRAAG 10*

10.1 galvanic/voltaic cell ✓
galvaniese/voltaïese sel [12.2.1] (1)

10.2 Incomplete circuit/No salt bridge ✓
Onvoltooide stroombaan/Geen soutbrug [12.1.2] (1)

10.3 0,76 V ✓ [12.2.3] (1)

10.4 Zero ✓ [12.2.3] (1)

10.5 $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ ✓✓ [12.2.3] (2)

10.6.1 Mg ✓
Mg is oxidised/*Mg is geoksideer* ✓ [12.2.3] (2)

10.6.2 $E^0_{cell/sel} = E^0_{oxidising\ agent/oksideermiddel} - E^0_{reducing\ agent/reduseermiddel}$ ✓
$= - 0,76 \checkmark - (- 2,36) \checkmark$
$= + 1,6\ V \checkmark$ [12.2.3] (4)

10.6.3 As the cell functions, the concentration of zinc ions (reactants) decreases relative to standard conditions ✓and the concentration of magnesium ions (products) increases relative to standard conditions ✓. The reverse reaction starts opposing the forward reaction causing the emf to decrease relative to standard conditions.

Soos wat die sel funksioneer, neem die konsentrasie van sinkione (reaktanse) af relatief tot standaardtoestande en die konsentrasie van magnesiumione (produkte) neem toe relatief tot standaardtoestande. Die terugwaartse reaksie begin die voorwaartse reaksie teenwerk wat veroorsaak dat die emk afneem relatief tot standaardtoestande. [12.2.3] (2)

10.7
- Neutralise acid before disposal/*Neutraliseer suur voor weggooi* ✓
- Recycle plastic casing and lead electrodes/*Herwin plastiese omhulsels en loodelektrodes*✓

[12.3.3] (2)
[16]

QUESTION 11/*VRAAG 11*

11.1 cathode/*katode* ✓ [12.1.2] (1)

11.2 Silver/*silwer* ✓ [12.1.2] (1)

11.3 $Ag^+ + e^- \rightarrow Ag$ ✓✓ [12.2.3] (2)

11.4 The rate of oxidation of silver at the anode ✓is equal to the rate of reduction of silver ions at the cathode. ✓
Die tempo van oksidasie van silwer by die anode is gelyk aan die tempo van reduksie van silwerione by die katode. [12.1.4] (2)

11.5 Plastic is a non-conductor/Graphite is a conductor ✓✓
Plastiek is 'n nie-geleier/Grafiet is 'n geleier [12.3.2] (2)

11.6 Platinum is expensive/more durable than other metals ✓
Platinum is duur/meer duursaam as ander metale [12.3.3] (1)
[9]

QUESTION 12/*VRAAG 12*

12.1 Fractional distillation of (liquid) air ✓
Fraksionele distillasie van vloeibare lug [12.1.2] (1)

12.2 $N_2 + 3\ H_2$ ✓ ⇌ $2\ NH_3$ ✓ bal ✓ [12.1.2] (3)

12.3 $2SO_2 + O_2$ ✓⇌ $2SO_3$ ✓ bal ✓ [12.2.1] (3)

12.4 $H_2S_2O_7$ ✓
Oleum/pyrosulphuric acid/*piroswa(w)elsuur* ✓ [12.2.1] (2)

12.5 $(NH_4)_2SO_4$ ✓✓
Ammonium sulphate/*ammoniumsulfaat* ✓ [12.1.2] (3)

12.6.1
- Soil cannot replenish nutrients at a fast enough rate to sustain growth. *Grond kan nie voedingstowwe teen 'n voldoende tempo (vinnig genoeg)* aanvul om groei te onderhou nie. ✓
- Globally a bigger demand for food/*Globale hoër aanvraag na voedsel* ✓

[12.3.3] (2)

12.6.2
- Increase in oil price/*Styging in olieprys* ✓
- Increase in price of raw materials/*Styging in prys van grondstowwe*✓

[12.3.2] (2)
[17]

TOTAL SECTION/*TOTAAL AFDELING B*: 115

GRAND TOTAL/*GROOTTOTAAL*: 150

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PHYSICAL SCIENCES GRADE 12 PAPER 2
FISIESE WETENSKAPPE GRAAD 12 VRAESTEL 2

Learning Outcomes and Assessment Standards *Leeruitkomste en Assesseringstandaarde*		
LO1/*LU1*	**LO2/*LU2***	**LO3/*LU3***
AS12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables. *Ontwerp, beplan en voer 'n wetenskaplike ondersoek uit om data te versamel ten opsigte van akkuraatheid, betroubaarheid en die kontroleer van veranderlikes.* **AS12.1.2:** Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations. *Soek patrone en tendense, stel dit in verskillende vorms voor, verduidelik die tendense, gebruik wetenskaplike beredenering om gevolgtrekkings te maak en te evalueer, en formuleer veralgemenings.* **AS12.1.3:** Select and use appropriate problem-solving strategies to solve (unseen) problems. *Kies en gebruik geskikte probleem-oplossingstrategieë om (ongesiene) probleme op te los.* **AS12.1.4:** Communicate and defend scientific arguments with clarity and precision. *Kommunikeer en verdedig wetenskaplike argumente duidelik en presies.*	**AS12.2.1:** Define, discuss and explain prescribed scientific knowledge. *Definieer, bespreek en verduidelik voorgeskrewe wetenskaplike kennis.* **AS12.2.2:** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in the candidate's own words. *Verduidelik en druk voorgeskrewe wetenskaplike beginsels, teorieë, modelle en wette uit deur die verwantskap tussen verskillende feite en konsepte in die kandidaat se eie woorde aan te dui.* **AS12.2.3:** Apply scientific knowledge in everyday-life contexts. *Pas wetenskaplike kennis in kontekste van die alledaagse lewe toe.*	**AS12.3.1** Research, discuss, compare and evaluate scientific and indigenous knowledge systems and knowledge claims by indicating the correlation among them, and explain the acceptance of different claims. *Doen navorsing, bespreek, vergelyk en evalueer wetenskaplike en inheemse kennissisteme en kennisaansprake deur die ooreenkoms tussen hulle aan te dui, en verduidelik die aanvaarding van verskillende aansprake.* **AS12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications. *Vors gevallestudies na en lewer etiese en morele argumente uit verskillende perspektiewe om die impak (voordele en nadele) van verskillende wetenskaplike en tegnologiese toepassings aan te dui.* **AS12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally. *Evalueer die impak van wetenskaplike en tegnologiese navorsing en dui die bydrae tot bestuur, benutting en ontwikkeling van bronne aan om volhoubaarheid kontinentaal en globaal te verseker.*

 Please turn over/*Blaai om asseblief*

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1	Cracking / *Kraking* ✓	[12.2.1]	(1)
1.2	Collision theory / *Botsingsteorie* ✓	[12.2.1]	(1)
1.3	Activation energy / *Aktiveringsenergie* ✓	[12.2.1]	(1)
1.4	Oxidising agent / *Oksideermiddel* ✓	[12.2.1]	(1)
1.5	Eutrophication / *Eutrofisering* ✓	[12.2.1]	(1) **[5]**

QUESTION 2/*VRAAG 2*

2.1	primary alcohol / *primêre alkohol* ✓✓	[12.2.3]	(2)
2.2	substitution reaction. / *substitusiereaksie* ✓✓	[12.2.3]	(2)
2.3	... increases *the rate of a chemical reaction. / verhoog die tempo van 'n chemiese reaksie.*	[12.2.2]	(2)
2.4	the electrolyte is a solution of a soluble silver compound. / *die elektroliet is 'n oplossing van 'n oplosbare silwerverbinding.* ✓✓	[12.2.3]	(2)
2.5	Carbon, hydrogen and oxygen .../ *Koolstof, waterstof en suurstof ...*✓✓ OR/*OF* ... the three primary nutrients .../... die drie primêre voedingstowwe ...	[12.2.2]	(2) **[10]**

QUESTION 3/*VRAAG 3*

3.1	D ✓✓	[12.2.3]	(2)
3.2	A ✓✓	[12.2.3]	(2)
3.3	B	[12.1.2]	(2)
3.4	B ✓✓	[12.1.2]	(2)
3.5	A ✓✓	[12.2.3]	(2) **[10]**

TOTAL SECTION A/*TOTAAL AFDELING A: 25*

 Please turn over/*Blaai om asseblief*

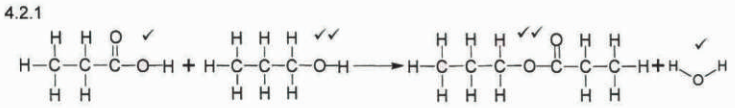
SECTION B/*AFDELING B*

QUESTION 4/*VRAAG 4*

4.1  ✓ OR/*OF*

NOTE: The structural formula of a compound shows which atoms are attached to which within the molecule. The atoms are represented by their chemical symbols, and lines are used to represent the bonds that hold the atoms together.
LET WEL: *Die struktuurformule van 'n verbinding toon watter atome aan watter in die molekuul gebind is. Die atome word voorgestel deur hul chemiese simbole, en lyne word gebruik om die bindings tussen atome voor te stel.*

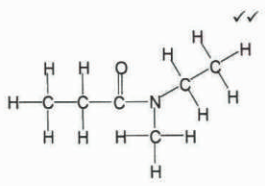
[12.2.1] (1)

4.2.1 

[12.2.3] (6)

4.2.2 Propyl propanoate / *Propielpropanoaat* ✓ [12.2.3] (1)

4.2.3 (concentrated) sulphuric acid / *(gekonsentreerde) swaelsuur* ✓ [12.2.3] (1)

4.3.1 

[12.2.3] (2)

4.3.2 *N*-ethyl-*N*-methylpropanamide ✓ (1)
N-etiel-N-metielpropaanamied [12.2.2] **[12]**

 Please turn over/*Blaai om asseblief*

QUESTION 5/*VRAAG 5*

5.1.1	Carboxylic acids / *Karboksielsure* ✓	[12.2.3]	(1)
5.1.2	Alcohols / *Alkohole* ✓	[12.2.3]	(1)
5.1.3	Aldehydes / *Aldehiede* ✓	[12.2.3]	(1)
5.2.1	Propanal ✓	[12.2.3]	(1)
5.2.2	Pentan-1-ol ✓	[12.2.3]	(1)

5.3

Criteria for investigative question / *Kriteria vir ondersoekende vraag:*	**Mark**
Refers to relationship between dependent and independent variables. / *Verwys na die verwantskap tussen die afhanklike en onafhanklike veranderlikes.*	✓✓
Is stated as an question, not an aim. / Is as 'n vraag gestel, nie 'n doel nie.	

OPTION 1/*OPSIE 1*
Relationship: Boiling point and type of functional group/homologous series
Verwantskap: Kookpunt en tipe funksionele groep/homoloë reeks

Examples / *Voorbeelde:*

- What is the relationship between boiling point and the type of functional group / type of homologous series? ✓✓
  Wat is die verwantskap tussen kookpunt en die tipe funksionele groep / tipe homoloë reeks?

OR/*OF*

- How does the boiling points of the carboxylic acid, aldehyde and alcohol compare? (
  Hoe vergelyk die kookpunte van karboksielsure, aldehiede en alkohole?

OR/*OF*

- How do the boiling points of compounds from the three homologous series differ / compare?
  Hoe verskil / vergelyk kookpunte van verbindings van die drie homoloë reekse?

 Please turn over/*Blaai om asseblief*

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OPTION 2/*OPSIE 2*
Relationship: Boiling point and **chain length / molar mass/ molecular size**
(of compounds with same functional group / from same homologous series).
***Verwantskap:* Kookpunt** *en* **kettinglengte / molêre massa / molekuulgrootte**
(van verbindings met dieselfde tipe funksionele groep / van dieselfde homoloë reeks).

Examples / *Voorbeelde:*
- What is the relationship between boiling point and chain length / molar mass / molecular size? ✓✓
  Wat is die verwantskap tussen kookpunt en kettinglengte / molêre massa / molekuulgrootte?

OR/*OF*
- How does chain length / molar mass / molecular size influence boiling point? / *Hoe beïnvloed kettinglengte / molêre massa / molekuulgrootte die kookpunt?*

[12.1.1] (2)

5.4 **If Option 1 in Question 5.3 / *Indien Opsie 1 in Vraag 5.3:***

Molar mass / molecular mass / formula mass✓
Molêre massa / molekulêre massa / formule massa

If Option 2 in Question 5.3 / *Indien Opsie 2 in Vraag 5.3:*

Type of functional group / homologous series ✓
Tipe funksionele groep / homoloë reeks [12.1.1] (1)

5.5 Boiling point of carboxylic acids > alcohols > aldehydes. ✓✓
Kookpunte van karboksielsure > alkohole✓ > aldehiede. ✓✓ [12.1.2] (2)

5.6

Option 1/*Opsie 1*
Relationship: Boiling point and **type of functional group/homologous series**
***Verwantskap:* Kookpunt** *en* **tipe funksionele groep/homoloë reeks**

Carboxylic acids – highest boiling points due to strongest/more hydrogen bonding / formation of dimers. ✓
Alcohols – lower boiling points than carboxylic acids due to weaker/less hydrogen bonding higher boiling points than aldehydes due to strong hydrogen bonds between molecules. ✓
Aldehydes – lowest boiling points due to weak Van der Waals forces / weak intermolecular forces between molecules. ✓

Karboksielsure *– hoogste kookpunte a.g.v. sterkste/meer waterstobindings tussen molekule / vorm dimere.* ✓
Alkohole *– laer kookpunte as karboksielsure a.g.v. swakker/minder waterstofbindings tussen molekule. / hoër kookpunte as aldehiede a.g.v. sterk waterstofbindings tussen molekule.* ✓
Aldehiede *– laagste kookpunte a.g.v. swak Van der Waalskragte / swak intermolekulêre kragte tussen molekule.* ✓

OPTION 2/*OPSIE 2*

Relationship: Boiling point and **chain length / molar mass** (of compounds with same functional group / from same homologous series)
***Verwantskap:* Kookpunt** *en* **kettinglengte / molêre massa** *(van verbindings met dieselfde tipe funksionele groep / van dieselfde homoloë reeks)*

Compounds in Exp. 2 have **higher boiling points** than compounds in Exp. 1. ✓
Chain length of compounds in Exp. 2 **longer** than in Exp. 1. ✓
Van der Waals forces / intermolecular forces increase with increase in chain length / molecular size (number of electrons). ✓

Verbindings in Eksp. 2 het ***hoër kookpunte*** *as verbindings in Eksp. 1.* ✓
Kettinglengte *van verbindings in Eksp. 2* ***langer*** *as die in Eksp. 1.* ✓
Van der Waals kragte / intermolekulêre kragte neem toe met kettinglengte / molekuulgrootte (aantal elektrone). ✓

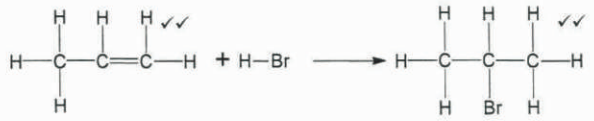
[12.1.4] (3)
[13]

QUESTION 6/*VRAAG 6*

6.1 Contains a double bond (between two carbon atoms). / *Bevat 'n dubbelbinding* (tussen twee koolstofatome). ✓

OR/*OF*
Carbon not bonded to the maximum number of (H) atoms.
Koolstof is nie aan die maksimum aantal (H)-atome gebind nie. [12.2.2] (1)

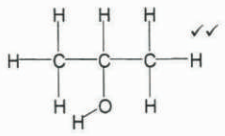
6.2



[12.1.2] (4)

6.3 Addition / hydrohalogenation / hydrobromination ✓
Addisie / hidrohalogenering / hidrobrominering [12.1.2] (1)

6.4



Propan-2-ol ✓
Accept/Aanvaar: 2-propanol [12.1.2] (3)

6.5 Hydrolysis / *hidrolise* ✓ [12.1.2] (1)

6.6.1 Water ✓ [12.2.3] (1)

6.6.2 H_3PO_4 / H_2SO_4 / HCℓ / HBr ✓ [12.2.3] (1)

6.6.3 Addition / hydration ✓
Addisie / hidrasie / hidratering [12.2.3] (1)

6.7.1 prop-1-ene / *prop-1-een* [12.2.3] (1)

6.7.2 Dehydrohalogenation / *Dehidrohalogenering*

OR/*OF*
Elimination / *Eliminasie* [12.2.3] (1)
[15]

QUESTION 7/*VRAAG 7*

7.1 Smaller than / *kleiner as* ✓ [12.1.2] (1)

7.2

Criteria for hypothesis/*Kriteria vir hipotese*:	**Mark**
Refers to **relationship between dependent and independent variables.** / *Verwys na die* ***verwantskap tussen die afhanklike en onafhanklike veranderlikes.***	✓✓
Statement *that can be proved correct or incorrect.* – ***prediction based on (prior) knowledge.*** ***Stelling*** *wat reg of verkeerd bewys kan word* – ***voorspelling gebaseer op (vooraf) kennis.***	

7.2 Examples / *Voorbeelde:*

- Reaction rate (or volume of hydrogen gas produced per unit time) increases with increase in concentration.
  Reaksietempo (of volume waterstofgas gevorm per eenheidstyd) neem toe met toename in konsentrasie.

OR/*OF*
- Reaction rate (or volume of hydrogen gas produced per unit time) decreases with increase in concentration.
  Reaksietempo (of volume waterstofgas gevorm per eenheidstyd) neem af met afname in konsentrasie.

OR/*OF*
- The higher the concentration (of HCℓ) the faster the rate of the reaction.
  Hoe hoër die konsentrasie (van HCℓ) hoe vinniger die reaksietempo. [12.1.1] (2)

7.3 To make a fair comparison / test. ✓✓
Om dit 'n regverdige vergelyking / toets te maak.

OR/*OF*
Magnesium is a controlled variable. / Magnesium is 'n gekontroleerde veranderlike.
Accept: Magnesium is a constant.

OR/*OF*
To ensure that there is only one independent variable (concentration).
Om te verseker dat daar slegs een onafhanklike veranderlike (konsentrasie). [12.1.1] (2)

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7.4 Magnesium is the limiting reagent. ✓✓
Magnesium is die beperkende reagens.

OR/*OF*
When Mg is used up, the reaction will stop.
Wanneer Mg opgebruik is, sal die reaksie stop.

OR/*OF*
The same amount (mass/volume) of Mg will react with the same amount of acid in each experiment.
Dieselfde hoeveelheid (massa/volume) magnesium sal in elke eksperiment met dieselfde hoeveelheid suur reageer. [12.1.1] (2)

7.5.1 60 cm^3 ✓ [12.1.2] (1)

7.5.2 42 cm^3 ✓ [12.1.2] (1)

7.6 Experiment / *Eksperiment* 1 ✓

The gradient / slope (of tangent to graph) is steeper. ✓
Die gradiënt / helling (van die raaklyn aan die grafiek) is steiler. [12.1.2] (2)

7.7 The number of moles / amount / mass of Mg used in both experiments were the same. ✓
Die aantal mol / hoeveelheid / massa Mg gebruik in beide eksperimente was dieselfde. [12.1.1] (1)

7.8 Reaction rate increases with increase in concentration. ✓✓
Reaksietempo neem toe met toename in konsentrasie.

OR/*OF*
Reaction rate (volume of hydrogen gas formed per unit time) decreases with decrease in concentration.
Reaksietempo (volume waterstofgas gevorm per eenheidstyd) neem af met afname in konsentrasie. [12.1.2] (2)

7.9.1 Remains the same / *Bly dieselfde* ✓ [12.1.2] (1)

7.9.2 Increases / *Vermeerder* ✓ [12.1.2] (1)
[16]

QUESTION 8/*VRAAG 8*

8.1 Reactants and products are in different phases.
Reaktanse en produkte is in verskillende fases.

OR/*OF*
The reactant and one of the products are solids and the other product is a gas. / *Die reaktanse en een van die produkte is vaste stowwe en die ander produk is 'n gas.* [12.2.1] (1)

8.2

Option 1/*Opsie 1:*

$K_c = [CO_2]$ ✓
$0,0108 = [CO_2]$
$\therefore [CO_2] = 1,08 \times 10^{-2}$ mol·dm^{-3}

$n(CO_2) = cV$ ✓
$= (1,08 \times 10^{-2})$ ✓ (0,5) ✓
$= 5,4 \times 10^{-3}$ mol
$n(CaCO_3)_{used} = n(CO_2)$ ✓
$\therefore n(CaCO_3)_{used} = 5,4 \times 10^{-3}$ mol

$m(CaCO_3)_{used} = nM$ ✓$= (5,4 \times 10^{-3})(100)$ ✓ $= 0,54$ g

Mass/Massa (at equilibrium *by ewewig*) $= 5 \overset{✓}{-} 0,54 = 4,46$ g ✓

Option 2/*Opsie 2:*

$K_c = [CO_2]$ ✓

	$CaCO_3$	⇌	CaO +	CO_2
n(initial/*aanvanklik*):	0,05			0
n(react/*reageer*):	0,0054 ✓			0,0054
n(equilibrium/*ewewig*):				0,0054 ✓✓
c(equilibrium/*ewewig*):				0,0108 ✓

$n(CaCO_3)_i = \frac{m}{M}$
$= \frac{5}{100} = 0,05$ mol
$n(CaCO_3)_{eq.} = 0,05 \overset{✓}{-} 0,0054$
$= 0,045$ mol
$m(CaCO_3)_{eq./} = nM$ ✓
$= (0,045)(100)$ ✓
$= 4,46$ g ✓

$m(CaCO_3)_{used} = nM$ ✓
$= (5,4 \times 10^{-3})(100)$ ✓
$= 0,54$ g (0,5 g)
$m_{eq} = 5 \overset{✓}{-} 0,54$
$= 4,46$ g ✓

Option 3/*Opsie 3:*

$K_c = [CO_2]$ ✓ $= 0,0108 [CO_2] = 1,08 \times 10^{-2}$ mol·dm^{-3}

$n(CO_2) = cV$ ✓
$= (1,08 \times 10^{-2})$ ✓ (0,5) ✓
$= 5,4 \times 10^{-3}$ mol

	$CaCO_3$	⇌	CaO +	CO_2
n(initial/*aanvanklik*):	0,05			0
n(change/*verandering*):	0,0054 ✓			0,0054
n(equilibrium/*ewewig*):	0,0446 ✓			0,0054

$m(CaCO_3)_{used} = nM$ ✓ $= (0,0446)(100)$ ✓ $= = 4,46$ g ✓

Option 4/*Opsie 4:*

	$CaCO_3$	⇌	CaO +	CO_2
n(initial/*aanvanklik*):	0,05			0
n(change/*verandering*):	x			x ✓ (1:1)
n(equilibrium/*ewewig*):	0,05 – x			x
c(equilibrium/*ewewig*):				$\frac{x}{0,5}$ ✓ $(c = \frac{n}{V})$

$K_c = [CO_2]$ ✓ $= 0,0108$

$\frac{x}{0,5}$ ✓ $= 0,0108$ ✓ $\therefore x = 0,0054$ mol

$n(CaCO_3)_{initial} = \frac{m}{M} = \frac{5}{100} = 0,05$ mol

$n(CaCO_3)_{equilibrium} = 0,05 \overset{✓}{-} 0,0054 = 0,045$ mol

$m(CaCO_3)_{equilibrium\ /ewewig} = nM$ ✓
$= (0,045)(100)$ ✓
$= 4,46$ g ✓

$m(CaCO_3)_{used} = nM$ ✓
$= (5,4 \times 10^{-3})(100)$ ✓
$= 0,54$ g (0,5 g)
$m_{(equilibrium/ewewig)} = 5 \overset{✓}{-} 0,54$
$= 4,46$ g ✓

Option 5/*Opsie 5:*

$K_c = [CO_2]$ ✓

	$CaCO_3$	⇌	CaO +	CO_2
n(initial/*aanvanklik*):	0,05		0	0
m(initial/*aanvanklik*):	0,54 (0,5)		0,3024 ✓ (0,28)	0,2376✓
n(change/*verandering*):			0,0054 ✓	0,0054
n(equilibrium/*ewewig*):				0,0054 ✓✓
c(equilibrium/*ewewig*):				0,0108 ✓

$m(CaCO_3)_{equilibrium\ /ewewig} = 5 \overset{✓}{-} 0,54$
$= 4,46$ g ✓

[12.1.3] (9)

8.3 Endothermic / *Endotermies* ✓

According to Le Chatelier's principle an increase in temperature will favour the endothermic reaction. / the reaction that uses energy. ✓
When T was increased, K_c increased, therefore $[CO_2]$ increased / more products form, therefore forward reaction was favoured. ✓

Volgens Le Chatelier se beginsel sal 'n toename in temperatuur die endotermiese reaksie bevoordeel. / reaksie wat energie gebruik. ✓
Toe die temperatuur verhoog is, het Kc toegeneem, dus $[CO_2]$ het verhoog en dus is die voorwaartse reaksie bevoordeel. / ewewigsposisie skuif na regs. ✓ [12.1.4] (3)

8.4.1 Remains the same / *Bly dieselfde* ✓ [12.2.3] (1)

8.4.2 Increases / *Vermeerder* ✓ [12.2.3] (1)

8.4.3 Remains the same / *Bly dieselfde* ✓ [12.2.3] (1)

8.5 Remains the same / *Bly dieselfde* ✓ [12.2.3] (1)
[17]

Physical Sciences: Chemistry P2
November 2009
Memorandum

QUESTION 9/*VRAAG 9*

9.1 Temperature / *Temperatuur:* 298 K (25 °C) ✓
Concentration of electrolyte / *Konsentrasie van elektroliet:* 1 mol·dm^{-3} ✓ [12.2.1] (2)

9.2 $Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$ ✓✓ [12.2.3] (2)

9.3 $Mg(s) \mid Mg^{2+}(1 mol \cdot dm^{-3})$ ✓ ✓ $\parallel Pb^{2+}(s)$ $(1 mol \cdot dm^{-3}) \mid Pb(s)$ ✓ [12.2.3] (3)

9.4 $E^{\theta}_{Cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓
$= - 0,13$ ✓ $- (-2,36)$ ✓
$= 2,23$ V ✓ [12.2.3] (4)

9.5.1 Decreases / *Verminder* ✓ [12.2.2] (1)

9.5.2 Increases / *Vermeerder* ✓ [12.2.2] (1)

9.6 Half-cell A to half-cell B / *Halfsel A na halfsel B* ✓✓

- Concentration of positive ions / cations / Pb^{2+} ions decreases in half-cell B. / *Konsentrasie van positiewe ione / katione /* Pb^{2+}*-ions neem af in halfsel B.* ✓

  OR/OF
  Concentration of positive ions / cations/Mg^{2+} ions increase in half-cell A. ✓ / *Konsentrasie van positiewe ione / katione/* Mg^{2+}*-ione neem toe in halfsel A.*

- To prevent a build-up of positive ions in half-cell A and negative ions in half-cell B / For electrical neutrality, positive ions migrate from/through the salt bridge. ✓
  Om 'n opbou van positiewe ione in halfsel A en negatiewe ione in halfsel B te voorkom / Vir elektriese neutraliteit, migreer positiewe ione vanaf/deur die soutbrug. [12.1.4] (4)

[17]

QUESTION 10/*VRAAG 10*

10.1 The process in which electricity is used to bring about a chemical change / decompose/break compounds into components. / *Die proses waartydens elektrisiteit gebruik word om 'n chemiese verandering teweeg te bring / verbindings in komponente op te breek.* ✓✓

OR/*OF*
A process in which electrical energy is converted to chemical energy.
'n Proses waartydens elektriese energie omgeskakel word na chemiese energie. [12.2.1] (2)

10.2 P ✓

P is the positive (electrode) /anode. ✓
P *die positiewe electrode /anode.*

Oxidation takes place at the positive electrode/anode. ✓
Oksidasie vind by die positiewe elektrode (anode) plaas. [12.2.3] (3)

10.3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓✓ [12.2.3] (2)

10.4 Pt and Ag are both weaker reducing agents ✓(than copper) and will not be oxidised. ✓
Pt en Ag is beide swakker reduseermiddels (as koper) en sal nie geoksideer word nie.

OR/*OF*
Cu is a stronger reducing agent (than Pt and Ag) ✓
and will be oxidised. ✓/ *Cu is 'n sterker reduseermiddel (as Pt en Ag) en sal geoksideer word.* [12.2.3] (2)

10.5 The rate at which copper is oxidised (at the anode) is equal to the rate at which copper ions are reduced (at the cathode). ✓✓
Die tempo waarteen koper (by die anode) geoksideer word is gelyk aan die tempo waarteen koperione (by die katode) gereduseer word. [12.2.3] (2)

10.6 Contains valuable / expensive metals. ✓✓
Bevat waardevolle / duur metale.

OR/*OF*
Platinum and silver are valuable / expensive metals.
Platinum en silwer is waardevolle / duur metale. [12.3.2] (2)

[13]

QUESTION 11/*VRAAG 11*

11.1 A liquid / solution that conducts electricity. ✓✓

'n Vloeistof / oplossing wat elektrisiteit gelei. [12.2.1] (2)

11.2 Contains (positive / Na^+ and negative / $C\ell^-$) ions that are free to move. ✓
Bevat (positiewe / Na^+ *en negatiewe /* $C\ell^-$*) ione wat vry is om te beweeg.* [12.2.3] (1)

11.3 Chloride ions / Sodium chloride ✓
Chloriedione / Natriumchloried

$C\ell^-$ ions/$C\ell^-$ *-ione* Max./*Maks.* or/*of* $\frac{1}{2}$

Chloride ions are oxidised / lose electrons ✓ (to form $C\ell_2$).
Chloriedione word geoksideer / verloor elektrone (om $C\ell_2$ *te vorm).*

OR/OF
Chloride ions reduce water / causes reduction of water.
Chloriedione reduseer water / veroorsaak reduksie van water. [12.2.3] (2)

11.4 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓ [12.2.3] (2)

11.5 Anode ✓

$C\ell^-(aq)$ is oxidised to / *word geoksideer na* $C\ell_2(g)$ – oxidation at the anode / *oksidasie by die anode.* ✓

OR/*OF*
$2C\ell^-(aq) \rightarrow C\ell_2(g) + 2e^-$ [12.2.3] (2)

11.6 The (selectively permeable) membrane ✓ separates the chloride ions from the cathode compartment.
by allowing only positive ions / cations (Na^+) ✓ to move from the anode compartment to the cathode. / by preventing negative ions / anions to pass through.

Die (selektief-deurlaatbare) membraan skei die chloriedione van die katodekompartement deur slegs positiewe ione / katione (Na^+*) toe te laat om vanaf die anodekompartement na die katode te beweeg. / deur te verhoed dat negatiewe ione / anione daardeur gaan.* [12.2.1] (2)

11.7 Any ONE/*Enige EEN:*

- Chlorine is poisonous ✓/ dangerous / harmful to humans and the environment.
  Chloor is giftig ✓/ gevaarlik / skadelik vir mense en die omgewing.
- Leaching of sodium hydroxide into groundwater / water carriers is a health risk to humans and the environment.
  Insyfer van natriumhidroksied in grondwater / waterdraers hou 'n gesondheidrisiko vir mense en die omgewing in.
- Hydrogen gas can result in an explosion.
  Waterstofgas kan 'n ontploffing veroorsaak. [12.3.2] (1)

[12]

QUESTION 12/*VRAAG 12*

12.1 Secondary cells / *Sekondêre selle* ✓ [12.2.1] (1)

12.2.1 Equation / *vergelyking* II ✓

OR/*OF*
$NiO_2(s) + 2H_2O(\ell) + 2e^- \rightarrow Ni(OH)_2(s) + 2OH^-(aq)$

Reduction (takes place at cathode). / Electrons gained (at cathode) ✓
Reduksie (vind by die katode plaas). / Elektrone opgeneem (by katode) [12.2.3] (2)

12.2.2 $NiO_2(s) + Cd(s) + 2H_2O(\ell)$ ✓$\rightarrow Ni(OH)_2(s) + Cd(OH)_2(s)$ ✓ Bal ✓ [12.2.3] (3)

12.2.3 $W = Vq$ ✓
$= 1,4$ ✓x $2(9,65 \times 10^4)$ ✓
$= 2,7 \times 10^5$ J ✓

OR/*OF*
$W = Vq$ ✓
$= 1,4$ ✓ x $2(1,6 \times 10^{-19})(6,03 \times 10^{23})$ ✓
$= 2,7 \times 10^5$ J ✓ [12.2.3] (4)

[10]

TOTAL SECTION B/*TOTAAL AFDELING B*: 125

GRAND TOTAL/*GROOTTOTAAL*: 150

Physical Sciences: Physics P1
February/March 2009

SECTION A

Answer this section on the attached ANSWER SHEET.

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) on the attached ANSWER SHEET.

1.1 The force that acts on a body in free fall (1)

1.2 The ability to do work (1)

1.3 The phenomenon observed when a wave bends around the edges of an obstacle (1)

1.4 The law that describes the interaction between two point charges at rest (1)

1.5 Electromagnetic radiation with the shortest wavelength (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	A collision during which the kinetic energy changes	A	elastic
2.2	A unit of measure equal to the watt	B	wavefront
2.3	The imaginary line joining points in phase on a wave	C	low frequency electromagnetic waves
2.4	Energy of a charge due to its location in an electric field	D	$N \cdot m \cdot s^{-1}$
2.5	Radio waves	E	inelastic
		F	amplitude
		G	electric potential energy
		H	sound waves
		I	J·s
		J	potential difference

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 When a child exerts a horizontal force on a heavy crate, the crate does not move because the crate exerts an equal but opposite force on the child. (2)

3.2 The net (total) work done on a body that travels at constant speed is zero. (2)

3.3 As a source moves towards a stationary observer, the frequency of the source and the observed frequency changes. (2)

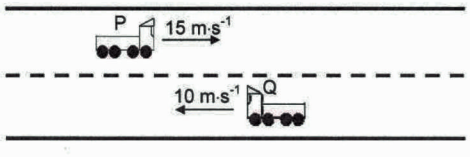
3.4 Current in a given conductor at constant temperature is inversely proportional to the potential difference across its ends. (2)

3.5 Sodium produces an emission spectrum that is different from its absorption spectrum. (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 The diagram below shows two trucks, P and Q, travelling in opposite directions along a straight level road. Truck P travels at 15 $m \cdot s^{-1}$ and truck Q travels at 10 $m \cdot s^{-1}$.



A passenger on truck P will observe truck Q travelling at

A $5\ m \cdot s^{-1}$

B $10\ m \cdot s^{-1}$

C $15\ m \cdot s^{-1}$

D $25\ m \cdot s^{-1}$ (3)

4.2 The engine of a car does work, *W*, to increase the velocity of the car from 0 to *v*. The work done by the engine to increase the velocity from **v to 2v**, is:

A *W*

B 2*W*

C 3*W*

D 4*W* (3)

4.3 The siren of a police car, travelling at a speed *v*, emits sound waves of frequency *f*.

Which ONE of the following best describes the frequency that will be observed by a passenger in a car following right behind the police car at a speed *v*?

A Zero

B Smaller than *f*

C Equal to *f*

D Greater than *f* (3)

4.4 A negatively charged plastic comb is brought close to, but does not touch, a small piece of paper. If the comb and the paper are now attracted to each other, the original charge on the paper was

A negative.

B positive.

C negative or neutral.

D positive or neutral. (3)

4.5 Which ONE of the following best describes the difference between laser light and fluorescent light?

A Laser light consists of more frequencies than fluorescent light.

B Laser light is coherent, monochromatic and collimated, while fluorescent light has none of these properties.

C Laser light is coherent and collimated, while fluorescent light is monochromatic.

D Fluorescent light is coherent and laser light is not. (3)
[15]

TOTAL SECTION A: 35

SECTION B

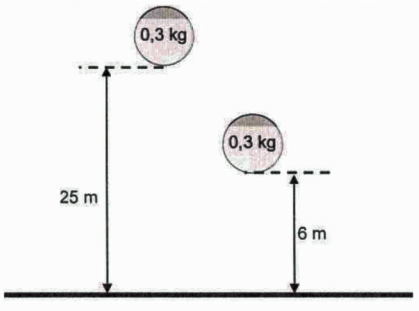
INSTRUCTIONS AND INFORMATION

1. Answer this section in the ANSWER BOOK.
2. The formulae and substitutions must be shown in ALL calculations.
3. Round off your answers to TWO decimal places where applicable.

QUESTION 5

The roof of a tall building is 25 m above the ground. A rigid ball of mass 0,3 kg falls freely when dropped from the roof. It strikes the concrete floor on the ground with velocity v_1. It bounces to a maximum vertical height of 6 m.

The ball was in contact with the floor for 0,9 s. Ignore the effects of friction.



5.1 Calculate the velocity v_1 when the ball first hits the floor. (3)

5.2 Calculate the impulse of the ball as a result of the collision. (7)

5.3 Calculate the magnitude of the net force exerted on the ball. (3)

5.4 Using the ground as zero reference, draw a sketch graph of position (displacement) versus time for the motion of the ball from its original height until it reaches its second maximum height. Indicate the relevant position values on the y-axis. (4)

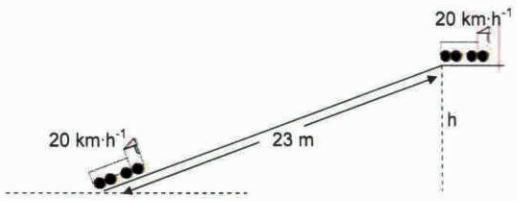
5.5 The rigid ball is now replaced with a softer ball of the same mass and volume as the rigid ball. It is then dropped from the same height onto the concrete floor.

Will the ball reach the SAME, GREATER or LESSER height compared to the previous ball? Use principles of physics to explain your answer. (3)
[20]

QUESTION 6

In South Africa the transportation of goods by trucks adds to the traffic problems on our roads.

A 10 000 kg truck travels up a straight inclined road of length 23 m at a constant speed of 20 km·h^{-1}. The total work done by the engine of the truck to get there is 7 x 10^5 J. The work done to overcome friction is 8,5 x 10^4 J.



6.1 Calculate:

6.1.1 The height, h, reached by the truck at the top of the road (6)

6.1.2 The instantaneous power delivered by the engine of truck (6)

6.2 Arrestor beds are constructed as a safety measure to allow trucks to come to rest when their brakes fail whilst going downhill. Write down TWO design features of such arrestor beds. (2)
[14]

QUESTION 7

Dolphins use ultrasound to scan their environment.

When a dolphin is 100 m from a rock, it emits ultrasound waves of frequency 250 kHz whilst swimming at 20 m·s^{-1} towards the rock. Assume that the speed of sound in water is 1 500 m·s^{-1}.

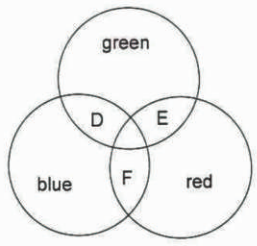
7.1 Calculate the frequency of the sound waves detected by a detector on the rock. (4)

7.2 When the dolphin is 50 m from the rock, another ultrasound wave of 250 kHz is emitted.

How will the frequency of the detected sound waves compare with the answer calculated in QUESTION 7.1? Write down only HIGHER, LOWER or REMAINS THE SAME. Explain your answer. (2)
[6]

QUESTION 8

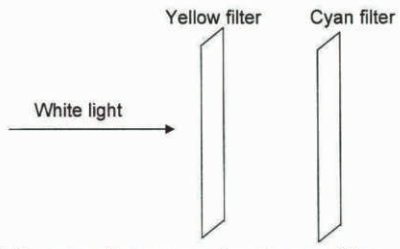
8.1 The diagram below shows the three primary colours of light. Each of D, E and F in the diagram below is obtained by adding a pair of primary colours. This is the basis of how technology may use colour to produce desired colour effects as is done in the television.



8.1.1 Which THREE colours are represented by the letters D, E and F respectively? (3)

8.1.2 Why are the colours red, blue and green referred to as primary colours? (2)

8.2 White light passes through a yellow filter, which is in turn followed by a cyan filter as shown in the diagram below.



8.2.1 Identify the colour that emerges from the cyan filter. (1)

8.2.2 Explain your answer to QUESTION 8.2.1. (4)

8.2.3 The cyan filter is now replaced with a magenta filter. What colour will emerge from the magenta filter? (1)
[11]

QUESTION 9

Huygens's principle is used to explain the wave phenomena, interference and diffraction.

9.1 State Huygens's principle. (2)

9.2 Use Huygens's principle to explain the diffraction of water waves in a ripple tank as they pass through a narrow opening in a barrier. (3)

9.3 A single slit of unknown width is illuminated with red light of wavelength 650 nm.

Calculate the width of the slit for which the first dark band will appear at 15°. (3)
[8]

QUESTION 10

Each plate of a parallel plate capacitor has an area of 40 cm^2. The plates are 1 cm apart. The capacitor is connected to a 12 V DC supply.

10.1 Calculate the magnitude of the charge on each plate. (5)

10.2 By which factor will the charge calculated in QUESTION 10.1 change if the area of each parallel plate is changed to 20 cm^2?

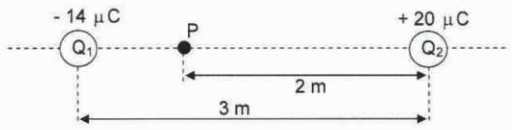
Explain your answer in terms of physics principles and the charge stored in the capacitor. (NO calculations needed.) (3)

10.3 What is the net charge on the capacitor? (1)

10.4 Capacitors are used in flash cameras. Give a reason for this use. (1)
[10]

QUESTION 11

Two point charges, Q_1 and Q_2, a distance 3 m apart, are shown below. The charge on Q_1 is - 14 μC and the charge on Q_2 is + 20 μC.



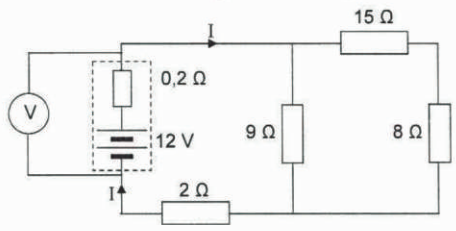
11.1 Define the *electric field* at a point in space. (2)

11.2 Draw the electric field pattern due to these two charges. (3)

11.3 Calculate the net electric field at point P situated 2 m from Q_2. (5)
[10]

QUESTION 12

The battery in the circuit below has an emf of 12 V and an internal resistance of 0,2 Ω. The resistance of the connecting wires can be ignored.

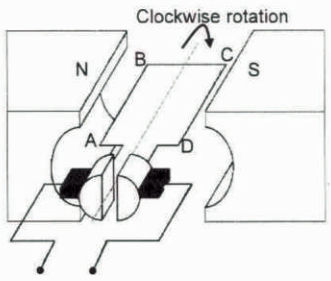


12.1 Calculate the current, I, that flows through the battery. (6)

12.2 How will the reading on the voltmeter be affected if the 9 Ω resistor is removed and replaced with a conducting wire of negligible resistance? Explain your answer. (4)
[10]

QUESTION 13

13.1 Electric motors are used in pumps, fans and compressors. Electric motors can be either AC or DC. The diagram below illustrates one of these types of electric motors.



13.1.1 What type of electric motor (AC or DC) is illustrated in the diagram?

Give a reason for your answer. (2)

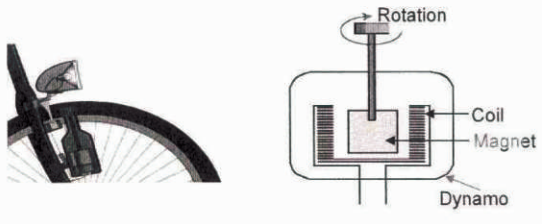
13.1.2 If the loop turns in a clockwise direction, in what direction is the current in section AB of the loop flowing in the above diagram? Write down from A to B, or from B to A only. (1)

The motor in the diagram is now changed to operate as a generator.

13.1.3 On what principle does a generator operate? (1)

13.1.4 Draw a sketch graph of the potential difference versus time for this generator while it is functioning. (2)

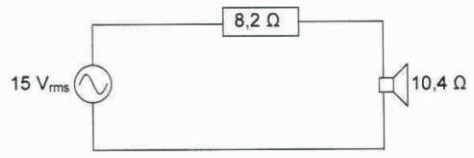
13.2 The diagram below shows a dynamo attached to the wheel of a bicycle. When riding a bicycle, the wheel rotates a magnet near a coil.



Explain how a current is induced in the coil. (2)
[8]

QUESTION 14

14.1 In the circuit below the AC source delivers alternating voltages at audio frequency to the speaker.



14.1.1 What is the peak voltage that the source can deliver? (2)

14.1.2 Calculate the average power delivered to the speaker. (6)

14.2 Alternating current is generated at power stations.

Name TWO advantages of AC transmission over long distances. (2)
[10]

QUESTION 15

The work function of three metals is shown in the table below.

METAL	WORK FUNCTION (W_0) in J
Aluminium	$6,54 \times 10^{-19}$
Zinc	$6,89 \times 10^{-19}$
Silver	$7,58 \times 10^{-19}$

15.1 Give a reason why different metals have different work functions. (1)

15.2 Light of wavelength $2,3 \times 10^{-7}$ m is shone onto a metal X. The average speed of the emitted electrons is $4,78 \times 10^5$ m·s^{-1}.

Identify metal X by performing a relevant calculation. (6)

15.3 What conclusion about the nature of light is drawn from the photo-electric effect? (1)
[8]

TOTAL SECTION B: 115

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES P1 GRADE 12

GEGEWENS VIR FISIESE WETENSKAPPE V1 GRAAD 12

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 m·s^{-2}
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8$ m·s^{-1}
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}$ J·s
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9$ N·m^{2}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·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* $v_f^{\ 2} = v_i^{\ 2} + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE/*KRAG*

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

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

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

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

$v = f\lambda$ or/*of* $v = \nu\lambda$	$T = \frac{1}{f}$ or/*of* $T = \frac{1}{\nu}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\nu$ or/*of* $E = h\frac{c}{\lambda}$
$\lambda = \frac{h}{mv}$	$\sin\theta = \frac{m\lambda}{a}$
$hf = W_0 + \frac{1}{2}mv^2$	

MATTER AND MATERIALS/*MATERIE EN MATERIALE*

$F = k\Delta x$	Stress/*Spanning* $= \frac{F}{A}$
Strain/*Vervorming* $= \frac{\Delta x}{\ell}$	

ELECTRICITY AND MAGNETISM/*ELEKTRISITEIT EN MAGNETISME*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$
$\Phi = BA$	$P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$ $P_{average} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$ $P_{average} = I_{rms}^2R$ / $P_{gemiddeld} = I_{wgk}^2R$

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
$R_s = R_1 + R_2 + \ldots$	emf/*emk* $(\varepsilon) = I(R + r)$

**EXAMINATION NUMBER/
*EKSAMENNOMMER:***

ANSWER SHEET/*ANTWOORDBLAD*

QUESTION 1/*VRAAG 1*

1.1 _____ (1)
1.2 _____ (1)
1.3 _____ (1)
1.4 _____ (1)
1.5 _____ (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 _____ (1)
2.2 _____ (1)
2.3 _____ (1)
2.4 _____ (1)
2.5 _____ (1)
[5]

QUESTION 3/*VRAAG 3*

3.1 _____ (2)
3.2 _____ (2)
3.3 _____ (2)
3.4 _____ (2)
3.5 _____ (2)
[10]

QUESTION 4/*VRAAG 4*

4.1	A	B	C	D
4.2	A	B	C	D
4.3	A	B	C	D
4.4	A	B	C	D
4.5	A	B	C	D

(5 x 3) [15]

TOTAL SECTION A/*TOTAAL AFDELING A*: 35

SECTION A

Answer this section on the attached ANSWER SHEET.

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) on the attached ANSWER SHEET.

1.1 The product of force and velocity (1)

1.2 The type of collision in which kinetic energy is conserved (1)

1.3 The coloured bands produced when white light passes through a triangular prism (1)

1.4 A device used to store charge in an electric circuit (1)

1.5 A phenomenon that occurs in a LASER when there are more electrons in a high-energy state than in a lower energy state (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	A unit of measure equal to $kg \cdot m^2 \cdot s^{-2}$	A	opaque
2.2	The rate of change of momentum	B	electric field
2.3	Objects that absorb some light while reflecting others	C	net force
2.4	Electric potential energy per unit charge	D	joule
2.5	A source of monochromatic light	E	light bulb
		F	newton
		G	laser
		H	electric potential
		I	transparent
		J	impulse

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Write only 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 When work is done by a net force on an object moving along a horizontal plane, the kinetic energy of the object is constant. (2)

3.2 When car A, travelling at 20 $m \cdot s^{-1}$, approaches car B, travelling at 18 $m \cdot s^{-1}$ in the opposite direction, its speed relative to car B is 38 $m \cdot s^{-1}$. (2)

3.3 The degree of diffraction of a wave is directly proportional to its frequency. (2)

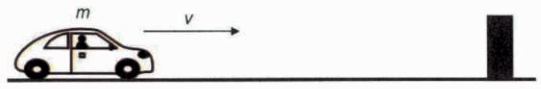
3.4 In a parallel plate capacitor, a dielectric increases capacitance by increasing the net electric field between the plates. (2)

3.5 In a laser, an incident photon leads to the creation of an identical photon travelling in the same direction as the incident photon. (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 A car of mass m moves along a straight line with a velocity of magnitude v. The driver sees an obstruction and immediately applies the brakes. The car stops uniformly in t seconds from the moment that the brakes are applied. The car does not hit the obstruction.



Which ONE of the following represents the MAGNITUDE of the average force exerted on the car during the braking period of t seconds?

A $\frac{v}{t}$

B mv

C $\frac{mv}{t}$

D mvt (3)

4.2 Consider the statements below:

I Work is done on an object when a force displaces the object in the direction of the force.

II Mechanical energy of a system is conserved when an external force does no work on the system.

III The work done on an object by a net force is equal to the kinetic energy of the object.

Which of the above statements is/are TRUE?

A Only I

B I and II only

C II and III only

D I, II and III (3)

4.3 Which ONE of the statements is CORRECT for the pigment cyan?

Cyan absorbs

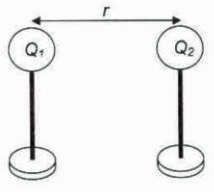
A red light while reflecting green and blue light.

B green light while reflecting red and blue light.

C blue light while reflecting green and red light.

D yellow light while reflecting green and blue light. (3)

4.4 The centres of two identical spheres are a distance r apart. They carry charges of Q_1 and Q_2 respectively as shown in the diagram below. Each sphere exerts an electrostatic force of magnitude F on the other.



The distance between the charges is now **halved** and the charge on Q_1 is **doubled.** The magnitude of the new force between the charges is

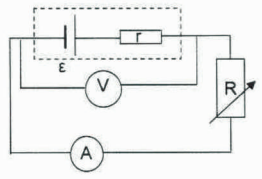
A F

B $2F$

C $4F$

D $8F$ (3)

4.5 In the circuit represented below, the resistance of the variable resistor is decreased.



How would this decrease affect the readings on the voltmeter and ammeter?

	Voltmeter reading	Ammeter reading
A	unchanged	unchanged
B	decreases	increases
C	decreases	unchanged
D	increases	increases

(3)
[15]

TOTAL SECTION A: 35

SECTION B

INSTRUCTIONS AND INFORMATION

1. Answer SECTION B in the ANSWER BOOK.
2. The formulae and substitutions must be shown in ALL calculations.
3. Round off your answers to TWO decimal places.

QUESTION 5

The most common reasons for rear-end collisions are too short a following distance, speeding and failing brakes. The sketch below represents one such collision. Car A of mass 1 000 kg, stationary at a traffic light, is hit from behind by Car B of mass 1 200 kg, travelling at 18 $m \cdot s^{-1}$. Immediately after the collision Car A moves forward at 12 $m \cdot s^{-1}$.

5.1 Assume that linear momentum is conserved during this collision. Calculate the speed of Car B immediately after the collision. (4)

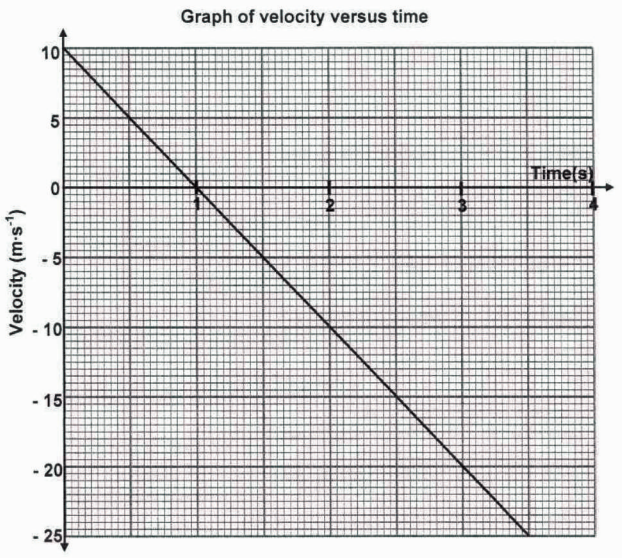
5.2 Modern cars are designed to crumple partially on impact. Explain why the assumption made in QUESTION 5.1 may NOT be valid in this case. (2)

5.3 A traffic officer appears at the scene of the accident and mentions the dangers of a head-on collision. He mentions that for cars involved in a head-on collision, the risk of injury for passengers in a heavier car would be less than for passengers in a lighter car.

Use principles of Physics to explain why the statement made by the traffic officer is correct. (3)
[9]

QUESTION 6

A boy stands at the edge of a high cliff. He throws a stone vertically upwards with an initial velocity of 10 $m \cdot s^{-1}$. The stone strikes the ground at a point below the cliff after 3,5 s. The velocity-time graph below was obtained from *measurements* made during the motion of the stone.



Use the information on the graph to answer the following questions:

6.1 Calculate the acceleration of the stone between times t = 2 s and t = 3 s. (3)

6.2 At which time(s) is the stone moving at a speed of 5 $m \cdot s^{-1}$? (2)

6.3 After how many seconds does the stone reach its highest point? (1)

6.4 Determine the height of the cliff from which the stone was thrown. (4)

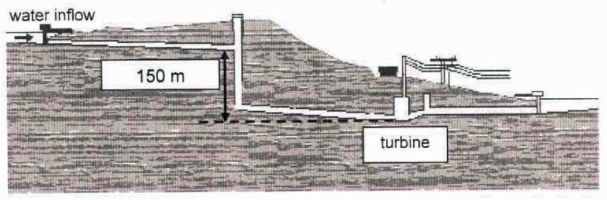
6.5 Using the top of the cliff as the initial position of the stone, sketch the position-time graph (displacement-time graph) for the motion of the stone **from its highest point until it reaches the ground**. Only indicate relevant time values on the x-axis. (3)
[13]

QUESTION 7

The diagram below represents how water is funnelled into a pipe and directed to a turbine at a hydro-electric power plant. The force of the falling water rotates the turbine.

Each second, 200 m^3 of water is funnelled down a vertical shaft to the turbine below. The vertical height through which the water falls upon reaching the turbine is 150 m. Ignore the effects of friction.

NOTE: One m^3 of water has a mass of 1 000 kg.



7.1 Calculate the mass of water that enters the turbine each second. (1)

7.2 Calculate the kinetic energy of this mass of water when entering the turbine. Use energy principles. (4)

7.3 Calculate the maximum speed at which this mass of water enters the turbine. (3)

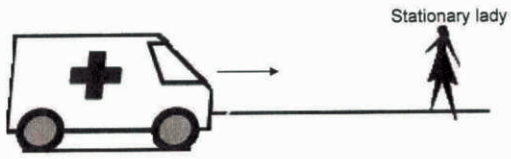
7.4 Assume that a generator converts 85% of this maximum kinetic energy gained by the water into hydro-electricity. Calculate the electrical power output of the generator. (2)

7.5 Explain what happens to the 15% of the kinetic energy that is NOT converted into electrical energy. (1)
[11]

QUESTION 8

An ambulance travelling down a road at constant speed emits sound waves from its siren. A lady stands on the side of the road with a detector which registers sound waves at a frequency of 445 Hz as the ambulance approaches her.

After passing her, and moving away at the same constant speed, sound waves of frequency 380 Hz are registered.



Assume that the speed of sound in air is 343 $m \cdot s^{-1}$.

8.1 Name the phenomenon that describes the change in the frequency observed by the lady. (1)

8.2 Calculate:

8.2.1 The speed at which the ambulance is moving (7)

8.2.2 The frequency at which the siren emits the sound waves (3)
[11]

QUESTION 9

A helium-neon laser emits red light that passes through a single slit. A diffraction pattern is observed on a screen some distance away from the slit.

9.1 Define the term *diffraction*. (2)

9.2 If the wavelength of red light is 644,4 nm and the slit width is 3 437 nm, calculate the angle at which the third minimum occurs. (3)

9.3 Briefly describe the diffraction pattern that will be observed on the screen. (2)

The single slit is replaced with a double slit.

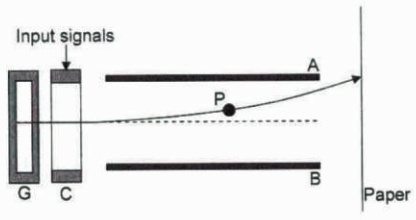
9.4 Name ONE similarity and ONE difference in the pattern observed when the single slit is replaced with a double slit. (2)

9.5 Will this pattern be observed if the laser is replaced with a light bulb? Give a reason for your answer. (2)
[11]

QUESTION 10

An ink-jet printer makes use of the electric field between two oppositely charged parallel plates to control the position of an ink drop on paper.

In the diagram below, the generator (G) of the printer shoots out ink drops that are charged in the charging unit C. The input signal from a computer controls the charge given to each ink drop. **P is a negatively charged ink drop.**



10.1 Define the electric field at a point in space. (2)

10.2 Is plate B negatively or positively charged? Give a reason for your answer. (2)

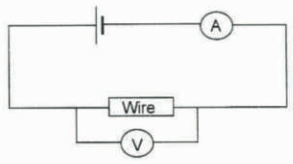
10.3 Sketch the electric field pattern between plates A and B. (2)

The plates A and B are $6,4 \times 10^{-4}$ m apart and ink drop P has a charge of magnitude $1,5 \times 10^{-13}$ C. When the ink drop enters the field it experiences an electrical force of $2,1 \times 10^{-7}$ N.

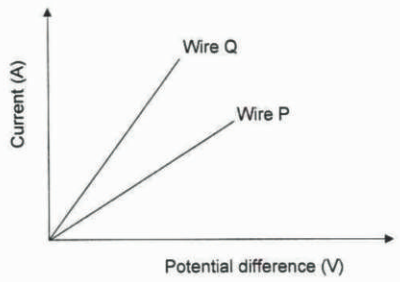
10.4 Calculate the potential difference across the parallel plates. (5)
[11]

QUESTION 11

Learners investigate the conducting ability of two metal wires P and Q, made of different materials. They connect ONE wire at a time in a circuit as shown below.



The potential difference across each wire is increased in equal increments, and the resulting current through these wires is measured. Using the measurements, the learners obtained the following sketch graphs for each of the wires.

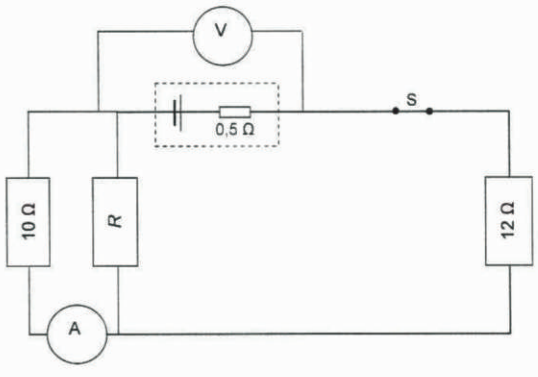


11.1 Name TWO variables that the learners would have controlled in each of the experiments. (2)

11.2 Which one (P or Q) is the better conductor? Explain your answer. (4)
[6]

QUESTION 12

A circuit is connected as shown below. The resistance of *R*, which is connected in parallel with the 10 Ω resistor, is unknown. With switch S closed, the reading on voltmeter V decreases from 45 V to 43,5 V. The internal resistance of the battery is 0,5 Ω.



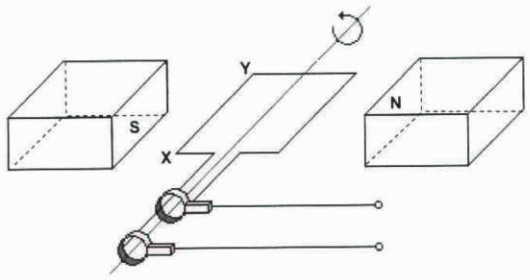
12.1 Calculate the reading on ammeter A. Show ALL your calculations. (8)

12.2 Determine the resistance of resistor *R*. (3)

12.3 How will the reading on voltmeter V change if resistor *R* burns out? Give a reason for your answer. (4)
[15]

QUESTION 13

A coil is rotated anti-clockwise in a uniform magnetic field. The diagram below shows the position at the instant the coil lies parallel to the magnetic field.



13.1 What type of generator is illustrated in the diagram? Give a reason for your answer. (2)

13.2 Determine the direction of the current in segment XY when the coil is in the position shown above. Only write down X to Y OR Y to X. (2)

13.3 Assume that the speed and direction of rotation are constant. Draw a sketch graph of potential difference against time that represents the output of this device. (2) **[6]**

QUESTION 14

The municipality of Dinaledin implements a power cutback in the town. As a result of the cutback the rms voltage drops from 220 V_{rms} to 200 V_{rms}.

14.1 Calculate the peak voltage during cutback. (3)

14.2 A certain electrical appliance dissipates 1 200 W when it is operated at 220 V_{rms}. Calculate the power at which it will operate during the cutback. (4)

14.3 It is common practice to connect many appliances to a multi-plug. Modern types of multi-plugs have a cut-off switch built in.

Using principles in Physics, explain clearly why this cut-off switch is important. (4) **[11]**

QUESTION 15

A fully automatic camera has a built-in light meter. When light enters the light meter, it strikes a metal object that releases electrons and creates a current.

15.1 What phenomenon is described by the underlined sentence? (1)

15.2 A metal plate is irradiated with electromagnetic radiation of wavelength 200 nm. The metal has a work function of $7{,}57 \times 10^{-19}$ J.

Show by calculation that the metal plate will emit photo-electrons when irradiated with radiation of this wavelength. (6)

15.3 The intensity of the incident radiation on the metal plate is increased whilst maintaining a constant wavelength of 200 nm. State and explain what effect this change has on the following:

15.3.1 Energy of the emitted photo-electrons (2)

15.3.2 Number of emitted photo-electrons (2) **[11]**

TOTAL SECTION B: 115

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES P1 GRADE 12

GEGEWENS VIR FISIESE WETENSKAPPE V1 GRAAD 12

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	$6{,}63 \times 10^{-34}\ J{\cdot}s$
Gravitational constant *Swaartekragkonstante*	G	$6{,}67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Coulomb's constant *Coulomb se konstante*	k	$9{,}0 \times 10^{9}\ N{\cdot}m^2C^{-2}$
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	$8{,}85 \times 10^{-12}\ F{\cdot}m^{-1}$
Permeability of free space *Permeabiliteit van vry ruimte*	μ_0	$4\pi \times 10^{-7}\ T{\cdot}m{\cdot}A^{-1}$

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

FORCE/*KRAG*

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

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

$W = F\Delta x\cos\theta$	$U = E_P = mgh$
$K = E_k = \frac{1}{2}mv^2$	$W = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

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

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

MATTER AND MATERIALS/*MATERIE EN MATERIALE*

$F = k\Delta x$	Stress/*Spanning* $= \frac{F}{A}$
Strain/*Vervorming* $= \frac{\Delta x}{\ell}$	

ELECTRICITY AND MAGNETISM/*ELEKTRISITEIT EN MAGNETISME*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$
$\Phi = BA$	$P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$ $P_{average} = \frac{V^2_{rms}}{R}$ / $P_{gemiddeld} = \frac{V^2_{wgk}}{R}$ $P_{average} = I^2_{rms}R$ / $P_{gemiddeld} = I^2_{wgk}R$

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESESTROOMBANE*

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$
$R_s = R_1 + R_2 + \ldots$	emf/*emk* (ε) = I(R + r)

NAME/EXAMINATION NUMBER: | | | | | | | | | | | | |

ANSWER SHEET

QUESTION 1

1.1 _____ (1)
1.2 _____ (1)
1.3 _____ (1)
1.4 _____ (1)
1.5 _____ (1)
[5]

QUESTION 2

2.1 _____ (1)
2.2 _____ (1)
2.3 _____ (1)
2.4 _____ (1)
2.5 _____ (1)
[5]

QUESTION 3

3.1 _____ (2)
3.2 _____ (2)
3.3 _____ (2)
3.4 _____ (2)
3.5 _____ (2)
[10]

QUESTION 4

4.1	A	B	C	D
4.2	A	B	C	D
4.3	A	B	C	D
4.4	A	B	C	D
4.5	A	B	C	D

(5 x 3) [15]

TOTAL SECTION A: 35

SECTION A

Answer this section on the attached ANSWER SHEET.

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) on the attached ANSWER SHEET.

1.1 A reaction in which the temperature of the mixture decreases (1)

1.2 The type of equilibrium in which the macroscopic properties (those visible to the naked eye) of the reaction mixture remain unchanged (1)

1.3 A loss of electrons during a redox reaction (1)

1.4 The electrolytic cell used for the industrial preparation of chlorine gas (1)

1.5 Atoms, groups of atoms or bonds that can be used to identify a homologous series (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	An aromatic hydrocarbon	A	anode
2.2	A unit in which reaction rate is measured	B	volt
		C	$mol \cdot dm^{-3}$
2.3	Equilibria where all the reagents are in the same phase	D	benzene
2.4	The positive electrode of an electrolytic cell	E	heterogeneous
		F	$mol \cdot s^{-1}$
2.5	A unit in which battery capacity is measured	G	cathode
		H	cyclohexene
		I	ampere-hour
		J	homogeneous

[5]

QUESTION 3: TRUE OR FALSE

Indicate whether the following statements are TRUE or FALSE. Write only 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 Esters and carboxylic acids can both be represented by the general formula $C_nH_{2n}O_2$. (2)

3.2 When the solution in equilibrium represented below is heated, it turns green.

$$Cu(H_2O)_6^{2+}(aq) + 4C\ell^-(aq) \rightleftharpoons CuC\ell_4^{2-}(aq) + 6H_2O(\ell) \qquad \Delta H > 0$$
blue green (2)

3.3 For the hypothetical reaction:
$A(aq) + B(aq) \rightleftharpoons C(aq) + D(aq)$

If at equilibrium $K_C = 10^{-4}$, then $[A][B] < [C][D]$. (2)

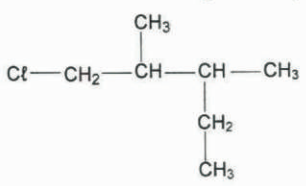
3.4 Zinc(II) sulphate can oxidise aluminium. (2)

3.5 During the catalytic oxidation of ammonia the platinum ensures a high concentration of products. (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 The condensed structural formula of an organic compound is given below.



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

A 1-chloro-2,3-dimethylbutane

B 1-chloro-2,3-dimethylpentane

C 1-chloro-3-ethyl-2-methylbutane

D 1-chloro-2-ethyl-3-methylpentane (3)

4.2 The boiling points of branched alkanes are lower than those of straight chain alkanes containing the same number of carbon atoms because branched alkane chains have ...

A larger molecular masses.

B shorter chain lengths.

C more electrons.

D smaller effective molecular surface areas. (3)

4.3 Which ONE of the following statements about the rate of reaction is INCORRECT?

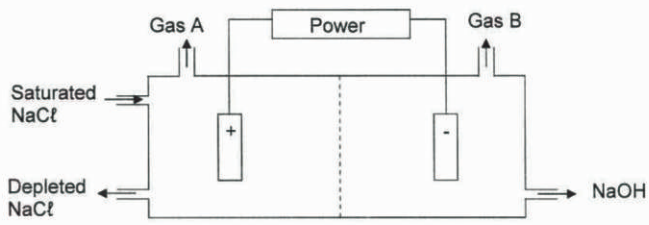
A Meat decays quicker in a warm environment than in a fridge.

B Most industrial processes are cheaper to run when a catalyst is used.

C Zinc reacts faster with excess dilute hydrochloric acid than with concentrated hydrochloric acid that is not in excess.

D Potatoes cook faster when sliced than when cooked whole. (3)

4.4 The diagram below shows a cell used to prepare chlorine gas and sodium hydroxide.



Which ONE of the following is applicable to the cell while it is functioning?

	Reaction at positive electrode	Gas A	Gas B
A	oxidation	hydrogen	chlorine
B	reduction	chlorine	hydrogen
C	oxidation	chlorine	hydrogen
D	oxidation	chlorine	oxygen

(3)

4.5 Nitrogen, phosphorus and potassium are ingredients in fertilisers. They are essential nutrients for plant growth and have the following functions:

- Nitrogen – for rapid growth and green leaves
- Phosphorus – for strong roots, fruit and flower development
- Potassium – protects against cold and dry weather

Your lawn has a well developed root system. You need a fertiliser that will provide nutrients for rapid growth and green leaves, and to protect the lawn during extreme dry conditions. Which ONE of the following fertiliser mixtures will you use on your lawn?

A 7:1:1

B 1:1:5

C 2:5:1

D 8:1:5 (3)
[15]

TOTAL SECTION A: 35

SECTION B

INSTRUCTIONS

1. Answer this section in the ANSWER BOOK.
2. The formulae and substitutions must be shown in ALL calculations.
3. Round off your answers to TWO decimal places.

QUESTION 5

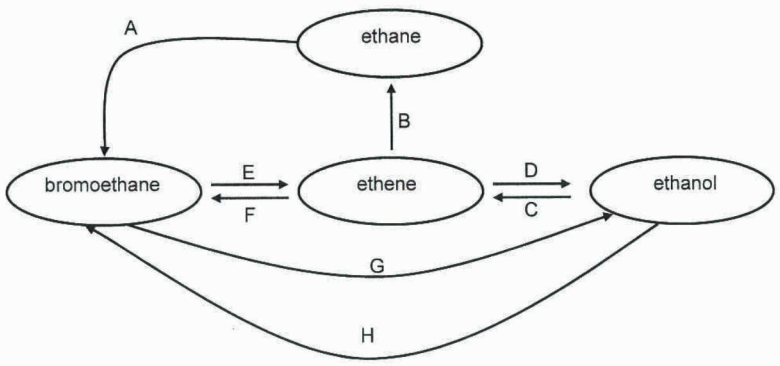
Ethene is a gaseous hormone associated with the ripening of fruit. It also contributes to the ageing and distortion of plants. In industry, the artificial ripening of fruit takes place when ethene is passed over the fruit in large rooms. After a while the ripening fruit releases its own ethene.

5.1 Write down the structural formula of ethene. (2)

5.2 Why is it not advisable to place a banana that has been artificially ripened alongside a cabbage and lettuce? (2)

In industry ethene is also used to synthesise a variety of organic compounds.

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



5.3 Write down the general formula for the homologous series to which ethene belongs. (1)

5.4 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)

5.5 Use structural formulae to write down a balanced equation for reaction B. (3)

5.6 Apart from ethene, which other reactant is needed for reaction F? Write down the FORMULA only. (2)

5.7 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.

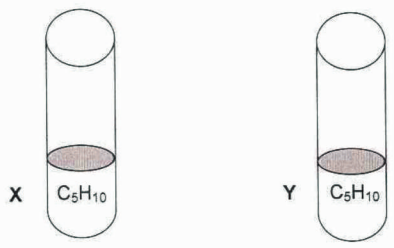
5.7.1 How is the base in reaction E different from the base in reaction G? (2)

5.7.2 Name the type of elimination reaction represented by E. (1)
[17]

QUESTION 6

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.



6.1 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):

6.1.1 Write down your investigative question. (2)

6.1.2 Write down a list of apparatus and chemicals you will use. (2)

6.1.3 State the safety precautions that you will take. (2)

6.1.4 Write down the procedure you will follow. (4)

6.2 Describe how you will use your observations to verify your hypothesis. (2)

6.3 Write down the IUPAC name of compound Y. (2)
[14]

QUESTION 7

More than 90 million organic compounds are known to man today. In the table below the letters A to E represent a few of these compounds.

	COMPOUND
A	$CH_3\,CH_2\,CH_2COH$ (O)
B	trimethylamine
C	$CH_3 - CH(OH) - CH_3$
D	6-methyl-1-heptene
E	$CH_3-C(=O)-N(CH_3)-CH_3$

7.1 Write down the IUPAC name of compound A. (1)

7.2 Write down the structural formula of compound D. (2)

7.3 To which homologous series does compound E belong? (1)

7.4 Write down the IUPAC name of an isomer of compound C. (2)

7.5 Compound B is one of the substances responsible for the fishy odour (smell) of fish. Explain why serving lemon slices with fish reduces the odour. (2)
[8]

QUESTION 8

8.1 The collision theory can be used to explain how different factors affect the rate of a chemical reaction.

8.1.1 Name TWO conditions that determine whether a collision between two molecules, A and B, will lead to a chemical reaction. (2)

8.1.2 In terms of the collision theory, explain why the rate of a chemical reaction increases with increasing temperature. (2)

8.2 The reaction between nitrogen dioxide and carbon monoxide is represented below.

$$NO_2(g) + CO(g) \rightarrow NO(g) + CO_2(g) \qquad \Delta H = -226\ kJ$$

The activation energy for the reaction, E_a, is 132 kJ.

8.2.1 Sketch a potential energy versus reaction coordinate graph for this reaction. Label the axes and indicate the following on your graph:

$\Delta H = -226$ kJ
$E_a = 132$ kJ (4)

8.2.2 Use a broken line on your graph to show the effect a catalyst would have on the potential energy as the reaction proceeds. (1)
[9]

QUESTION 9

In olden times the fertility of soil was achieved by allowing the land to lie fallow (unused). Alternatively, natural fertilisers such as manure and ground animal bones, which were ground, were used. Scientific research later established that fertilisers contained large quantities of nitrogen (N), phosphorus (P) and potassium (K).

While it was easy to obtain the minerals, the sources of nitrogen were very limited. As the world population grew, so did the demand for nitrogen-rich fertilisers. At the same time the sources of nitrogen were being depleted.

Fritz Haber designed a process which used nitrogen from the air and hydrogen from natural gas to manufacture ammonia. The process was also used to make ammonium nitrate which was used to manufacture explosives during World War I. Today the ammonia produced is used in the plastic industry and in many other products.

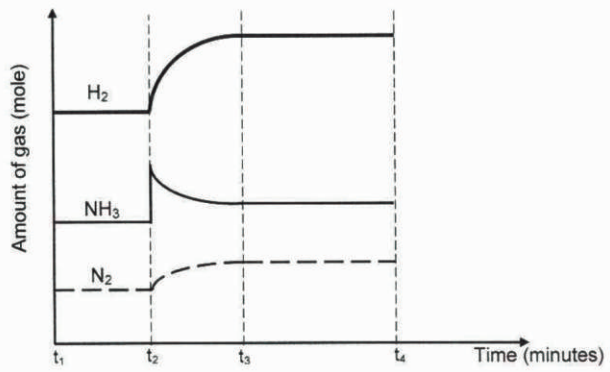
9.1 Write down TWO positive and TWO negative impacts of the Haber process on human and social development. (4)

The following equation represents a reversible reaction that has reached equilibrium at 470 °C in a closed container:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

A change was then made to the NH_3 in the equilibrium mixture at t_2. A graph showing the effect of this change is drawn below. (The graph is not drawn to scale.)

Graph of amount of gas versus time



9.2 What is the meaning of the horizontal lines between t_1 and t_2? (1)

9.3 State the change that was made to the NH_3 in the mixture at time t_2. (1)

9.4 Explain how the change mentioned in QUESTION 9.3, affected the concentration of H_2 and N_2 gases as shown in the graph. (3)

1,5 mol of $N_2(g)$ and 2 mol $H_2(g)$ were injected into a 0,5 dm^3 closed reaction vessel and allowed to reach equilibrium at 470 °C. When equilibrium was reached it was found that 1 mol of $NH_3(g)$ was present.

9.5 Calculate the equilibrium constant (K_C) at 470 °C. Show ALL your calculations. (8)

9.6 The temperature is now increased to 800 °C.

9.6.1 How will the value of K_C be affected if the temperature is increased to 800 °C? Write down only INCREASES or DECREASES or REMAINS THE SAME. (1)

9.6.2 Explain your answer to QUESTION 9.6.1. (2)
[20]

QUESTION 10

10.1 Rusting is an unwanted redox reaction. Iron rusts when exposed to oxygen and moisture. The unbalanced ionic equation for one reaction that occurs during rusting is represented below.

$$Fe(s) + O_2(g) + H_2O(\ell) \rightarrow Fe^{2+}(aq) + OH^-(aq)$$

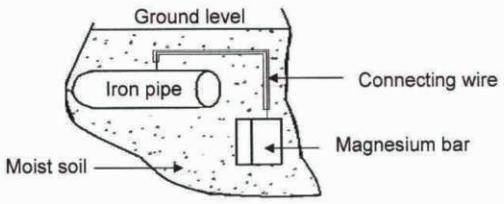
Use the Table of Standard Reduction Potentials (Table 4A or 4B) to answer the following questions for this reaction.

10.1.1 Write down the oxidation half-reaction. (2)

10.1.2 Write down the NAME of the substance that is reduced. (1)

10.1.3 Perform a calculation to verify that this reaction is spontaneous. (5)

10.2 Magnesium is used to protect underground iron pipes against rusting. The diagram below shows an iron pipe connected to a magnesium bar.



10.2.1 Use the Table of Standard Reduction Potentials (Table 4A or 4B) to explain why magnesium can be used to protect an iron pipe against rusting. (2)

10.2.2 The iron pipe in contact with the magnesium bar forms an electrochemical cell. What serves as the salt bridge of this cell? (2)

10.2.3 Give a reason why the magnesium bar must be replaced after some time. (1)

10.2.4 Write down a half-reaction to support your answer to QUESTION 10.2.3. (2)

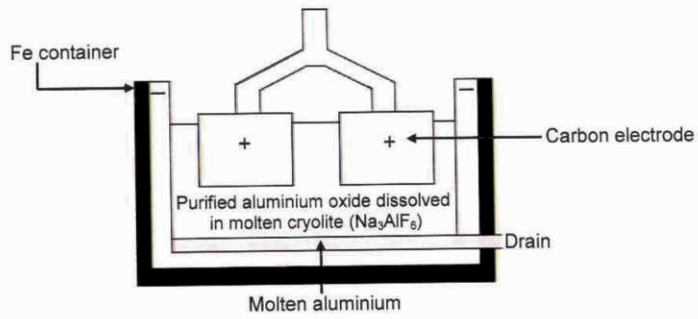
10.2.5 Name TWO other methods that can be used to protect iron pipes against rust. (2)

10.2.6 State ONE advantage and ONE disadvantage of using plastic pipes instead of iron pipes. (2)
[19]

QUESTION 11

Aluminium is one of the most abundant metals on earth, yet it is expensive – largely because of the amount of electricity needed to extract it. Aluminium ore is called bauxite. The bauxite is purified to yield a white powder, aluminium oxide, from which aluminium can be extracted.

The diagram below shows an electrolytic cell used for the extraction of aluminium at temperatures as high as 1 000 °C.



11.1 State the energy conversion that takes place in this electrolytic cell. (2)

11.2 Is aluminium formed at the positive or negative electrode? Write down POSITIVE or NEGATIVE only. (1)

11.3 Use the Table of Standard Reduction Potentials (Table 4A or 4B) to write down the half-reaction for the formation of aluminium. (2)

11.4 Explain why carbon dioxide gas is formed at one of the electrodes. (2)

11.5 Why should the carbon electrodes be replaced regularly? (2)

11.6 Write down TWO negative effects that the extraction of aluminium can have on the environment. (2)
[11]

QUESTION 12

DEAD ZONES EMERGING AS A BIG THREAT TO 21ST CENTURY FISH STOCKS

There are nearly 200 oxygen-starved or 'dead' zones in the world's oceans and seas. These 'dead' zones are linked to eutrophication caused by agricultural fertilisers, vehicle and factory emissions and wastes. Low levels of oxygen in the water make it difficult for important habitats such as sea grass beds, as well as organisms such as fish, oysters and other marine creatures, to survive.

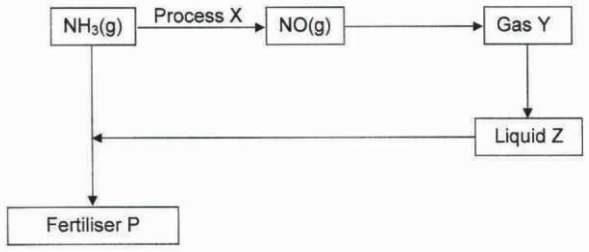
Nitrogen shortages are reducing farmers' chances of meeting food demands in parts of Africa. In many other parts of the world, however, excessive use of fertilisers is contributing to the escalating problem of 'dead' zones.

[Adapted from: *United Nations environmental programme*, News Centre, 2006]

12.1 Describe the process of eutrophication in water and how it leads to dead zones. (4)

12.2 Natural eutrophication takes place over thousands of years. Humans accelerate this process. Name TWO ways in which they do this. (2)

12.3 The flow diagram below represents the conversion of ammonia into nitrates.



12.3.1 What is the name of Process X? (1)

12.3.2 Write down a balanced equation for Process X. (3)

12.3.3 Write down the FORMULA for Gas Y. (2)

12.3.4 Write down a balanced equation for the preparation of fertiliser P. (3)

12.4 Name TWO ways according to which eutrophication can be reduced. (2)
[17]

TOTAL SECTION B: 115

GRAND TOTAL: 150

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n=\frac{m}{M}$	$c=\frac{n}{V}$
$c=\frac{m}{MV}$	$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$
	$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$
	$E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$

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

Half-reactions/*Halfreaksies*	E^θ (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 oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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)
1 H 1																	2 He 4
3 Li 7	4 Be 9											5 B 11	6 C 12	7 N 14	8 O 16	9 F 19	10 Ne 20
11 Na 23	12 Mg 24											13 Aℓ 27	14 Si 28	15 P 31	16 S 32	17 Cℓ 35,5	18 Ar 40
19 K 39	20 Ca 40	21 Sc 45	22 Ti 48	23 V 51	24 Cr 52	25 Mn 55	26 Fe 56	27 Co 59	28 Ni 59	29 Cu 63,5	30 Zn 65	31 Ga 70	32 Ge 73	33 As 75	34 Se 79	35 Br 80	36 Kr 84
37 Rb 86	38 Sr 88	39 Y 89	40 Zr 91	41 Nb 92	42 Mo 96	43 Tc	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 122	52 Te 128	53 I 127	54 Xe 131
55 Cs 133	56 Ba 137	57 La 139	72 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 Tℓ 204	82 Pb 207	83 Bi 209	84 Po	85 At	86 Rn
87 Fr	88 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/*SLEUTEL*

Atomic number *Atoomgetal* — Symbol *Simbool* — 29 Cu 63,5 — Approximate relative atomic mass *Benaderde relatiewe atoommassa* — Electronegativity *Elektronegatiwiteit*

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

Half-reactions/*Halfreaksies*	E^θ (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 oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

Learning Outcomes and Assessment Standards *Leeruitkomste en Assesseringstandaarde*		
LO1/*LU1*	**LO2/*LU2***	**LO3/*LU3***
AS 12.1.1: Design, plan and conduct a scientific inquiry to collect data systematically with regard to accuracy, reliability and the need to control variables. *Ontwerp, beplan en voer 'n wetenskaplike ondersoek uit om data te versamel ten opsigte van akkuraatheid, betroubaarheid en die kontroleer van veranderlikes.* **AS 12.1.2:** Seek patterns and trends, represent them in different forms, explain the trends, use scientific reasoning to draw and evaluate conclusions, and formulate generalisations. *Soek patrone en tendense, stel dit in verskillende vorms voor, verduidelik tendense, gebruik wetenskaplike beredenering om gevolgtrekkings te maak en te evalueer, en formuleer veralgemenings.* **AS 12.1.3:** Select and use appropriate problem-solving strategies to solve (unseen) problems. *Kies en gebruik geskikte probleemoplossingsstrategieë om (ongesiene) probleme op te los.*	**AS 12.2.1:** Define, discuss and explain prescribed scientific knowledge. *Definieer, bespreek en verduidelik voorgeskrewe wetenskaplike kennis.* **AS 12.2.2** Express and explain prescribed scientific principles, theories, models and laws by indicating the relationship between different facts and concepts in own words. *Verduidelik en druk voorgeskrewe wetenskaplike beginsels, teorieë, modelle en wette uit deur die verwantskap tussen verskillende feite konsepte in eie woorde aan te dui.* **AS 12.2.3:** Apply scientific knowledge in everyday life contexts. *Pas wetenskaplike kennis in kontekste van die alledaagse lewe toe.*	**AS 12.3.2:** Research case studies and present ethical and moral arguments from different perspectives to indicate the impact (pros and cons) of different scientific and technological applications. *Vors gevallestudies na en lewer etiese en morele argumente uit verskillende perspektiewe om die impak (voordele en nadele) van verskillende wetenskaplike en tegnologiese toepassings aan te dui.* **AS 12.3.3:** Evaluate the impact of scientific and technological research and indicate the contribution to the management, utilisation and development of resources to ensure sustainability continentally and globally. *Evalueer die impak van wetenskaplike en tegnologiese navorsing en dui die bydrae tot diebestuur, benutting en ontwikkeling van bronne aan om volhoubaarheid kontinentaal en globaal te verseker.*

SECTION A/*AFDELING A*

QUESTION 1/*VRAAG 1*

1.1 Gravitational force/*gravitasiekrag* ✓
or/*of*
weight/*gewig* [12.2.1] (1)

1.2 Energy/*energie* ✓ [12.2.1] (1)

1.3 Diffraction/*diffraksie* ✓ [12.2.1] (1)

1.4 Coulomb's law/*Coulomb se wet* ✓ [12.2.1] (1)

1.5 Gamma rays/*Gammastrale* ✓ [12.2.1] (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 E✓ [12.2.1] (1)

2.2 D✓ [12.2.1] (1)

2.3 B✓ [12.2.1] (1)

2.4 G✓ [12.2.1] (1)

2.5 C✓ [12.2.1] (1)
[5]

QUESTION 3/*VRAAG 3*

3.1 False/Onwaar ✓
the force applied by the child is too small to overcome the inertia of the crate/frictional forces.
die krag uitgeoefen deur die kind is te klein om die traagheid van die krat/wrywingskragte te oorkom.✓

OR/OF

the net force on the crate is zero. ✓
die nettokrag op die krat is nul. ✓ [12.2.3] (2)

3.2 True/*Waar* ✓✓ [12.2.2] (2)

3.3 False/*Onwaar* ✓
frequency of the source remains the same ✓
frekwensie van die bron bly dieselfde ✓ [12.2.2] (2)

3.4 False/*Onwaar*✓
directly proportional to the potential difference across its ends✓/ *direk eweredig aan die potensiaalverskil en omgekeerd eweredig aan die weerstand* [12.2.2] (2)

3.5 True/*Waar* ✓✓ [12.2.3] (2)
[10]

QUESTION 4/*VRAAG 4*

4.1 D ✓✓✓ [12.2.3] (3)

4.2 C ✓✓✓ [12.1.3] (3)

4.3 C ✓✓✓ [12.2.3] (3)

4.4 D ✓✓✓ [12.2.3] (3)

4.5 B ✓✓✓ [12.2.3] (3)
[15]

TOTAL SECTION A: 35
***TOTAAL AFDELING A:* 35**

SECTION B/*AFDELING B*

QUESTION 5/*VRAAG 5*

5.1 $v_f^2 = v_i^2 + 2a\Delta x$ ✓
$v_f^2 = (0)^2 + 2(-9,8)(25)$✓
v_f = - 22,13 or 22,13 m·s^{-1} down/*afwaarts*✓

OR/OF

E_t(top/*bo*) = E_t(bottom/*onder*)
$E_p + E_k = E_p + E_k$
$mgh + 0 = 0 + \frac{1}{2}mv_f^2$ ✓
$(0,3)(9,8)(25) + 0 = 0 + \frac{1}{2}(0,3)v_f^2$ ✓
v_f = 22,13 m·s^{-1} downward/*afwaarts*✓ [12.2.3] (3)

5.2 Consider upward motion as positive:/ *Beskou opwaartse beweging as positief:*
$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0 = v_i^2 + 2(-9,8)(6)^2$ ✓
v_i = 10,84 m·s^{-1} ✓

Impulse/*Impuls* = Δp ✓
= [(0,3)(10,84) – (0,3)(- 22,13)]✓
= + 9,89 N·s ✓ i.e. 9,89 N·s upward/*opwaarts*✓

OR/OF

Consider upward motion as negative:/*Beskou opwaartse beweging as negatief*
$v_f^2 = v_i^2 + 2a\Delta x$ ✓
$0 = v_i^2 + 2(9,8)(-6)^2$ ✓
v_i = - 10,84 m·s^{-1} ✓

Impulse/*Impuls* = Δp ✓
= [(0,3)(- 10,84) – (0,3)(22,13)]✓
= - 9,89 N·s✓ i.e. 9,89 N·s upward/*opwaarts* ✓

OR/OF

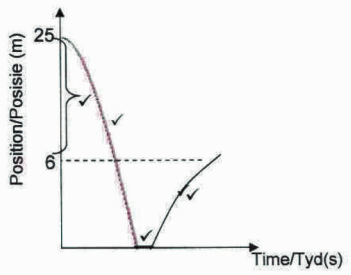
E_t(top/*bo*) = E_t(bottom/*onder*)
$E_p + E_k = E_p + E_k$
$mgh + 0 = 0 + \frac{1}{2}mv_f^2$ ✓
$(0,3)(9,8)(6) + 0 = 0 + \frac{1}{2}(0,3)v_f^2$ ✓
v_f = 10,84 m·s^{-1} upward/*opwaarts*✓

Impulse/*Impuls* = Δp ✓
= [(0,3)(10,84) – (0,3)(- 22,13)]✓
= + 9,89 N·s ✓ i.e. 9,89 N·s upward/*opwaarts*✓ [12.1.3] (7)

5.3 Take upward as positive:/*Neem opwaarts as positief:*
$F_{net}\Delta t = \Delta p$✓
$F_{net} = \frac{\Delta p}{\Delta t} = \frac{+9,89}{0,9}$ ✓ =+ 10,99 N✓i.e.10,99 N (11 N) upward/*opwaarts*

Take upward as negative:/*Neem opwaarts as negatief:*
$F_{net}\Delta t = \Delta p$✓
$F_{net} = \frac{\Delta p}{\Delta t} = \frac{-9,89}{0,9}$ ✓ = - 10,99 N ✓i.e. 10,99 N (11 N)
upward/*opwaarts* [12.2.3] (3)

5.4



Checklist/*Kontrolelys* Criteria for graph/*Kriteria vir grafiek*	Marks/ *Punte*
Maximum original height indicated as 25 m and height of 2nd bounce as 6 m *Maksimum oorspronklike hoogte aangedui as 25 m en hoogte van tweede hop as 6 m*	✓
Correct shape between 25 m and 0 m *Korrekte vorm tussen 25 m en 0 m*	✓
Graph on x-axis between first reaching the floor and 2nd bounce *Grafiek op x-as wanneer dit die vloer tref en die 2de hop*	✓
Correct shape between 0 m and 6 m. *Korrekte vorm van grafiek tussen 0 m en 6 m.*	✓

[12.1.2] (4)

5.5 Smaller ✓
Contact time for softer ball is longer ✓than for rigid ball
According to $F_{net}\Delta t = \Delta p$, the force exerted by floor on softer ball is smaller than on the rigid ball. ✓.
Kleiner
Kontak tyd vir sagter bal is langer ✓ as vir stewige bal
Volgens $F_{net}\Delta t = \Delta p$, is die krag deur die vloer op sagter bal uitgeoefen kleiner as die op die stewige bal. ✓. [12.3.2] (3)
[20]

QUESTION 6/*VRAAG 6*

6.1.1 $W_{net} = \Delta E_p + \Delta E_k$✓
$\therefore W_{net} = (mgh_f - mgh_i) + (\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2)$
$\therefore 7 \times 10^5$ ✓$- 8,5 \times 10^4$ ✓ $= 10\,000(9,8)(h_f - 0)$ ✓ + 0 ✓
$\therefore 6,15 \times 10^5 = 10\,000(9,8)h_f$
$\therefore h_f = 6,28$ m ✓

OR/*OF*

Useful work done = gain in Ep ✓ = mgh ✓
Bruikbare arbeid verrig = wins aan Ep ✓ = mgh ✓
$\therefore 7 \times 10^5$ ✓$- 8,5 \times 10^4$ ✓ $= 10\,000(9,8)h$ ✓
$\therefore 6,15 \times 10^5 = 10\,000(9,8)h_f$
$\therefore h = 6,28$ m ✓ [12.1.3] (6)

6.1.2 $W = F\Delta x \cos\theta$ ✓
$\therefore 7 \times 10^5 = F(23)(1)$ ✓
$\therefore F = 3,04 \times 10^4$ N ✓

$P = Fv$ ✓
$= (3,04 \times 10^4)(\frac{20\,000}{60 \times 60})$ ✓
$= 1,6 \times 10^5$ W ✓ [12.1.3] (6)

6.2 Any TWO/*Enige TWEE:*
Surface must provide sufficient friction like sand ✓
Must be long enough for vehicle to stop. ✓
Oppervlak moet genoeg wrywing lewer soos sand ✓
Moet lank genoeg wees om die voertuig tot stilstand te bring✓ [12.3.2] (2)
[14]

QUESTION 7/*VRAAG 7*

7.1 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$= (\frac{1500 \pm 0}{1500 - 20})$ ✓(250×10^3)✓

$= 253,38 \times 10^3$ Hz (253,38 kHz) ✓ [12.2.3] (4)

7.2 Remains the same ✓
The detected frequency is independent of the distance between the source and observer. ✓
Bly dieselfde ✓
Die waargenome frekwensie is onafhanklik van die afstand tussen die bron en die waarnemer✓ [12.2.2] (2)
[6]

QUESTION 8/*VRAAG 8*

8.1.1 D: cyan ✓/*siaan*✓
E: yellow ✓/*geel* ✓
F: magenta ✓/ *magenta*✓ [12.2.3] (3)

8.1.2 All other colours can be obtained by mixing of these three colours ✓✓ / *Al die ander kleure kan verkry word deur hierdie drie kleure te meng*✓✓ [12.2.1] (2)

8.2.1 Green ✓/*Groen* ✓ [12.2.3] (1)

8.2.2 The yellow filter transmits red and green ✓and absorbs blue light. ✓
The cyan filter transmits the green light ✓and absorbs the red light. ✓
Die geel filter laat rooi en groen lig deur✓ en absorbeer blou lig✓
Die siaanfilter laat groen lig deur ✓en absorbeer rooi lig✓ [12.2.3] (4)

8.2.3 Red ✓/*rooi* ✓ [12.2.3] (1)
[11]

QUESTION 9/*VRAAG 9*

9.1 Each point on the wavefront acts as a source of spherical secondary waves or wavelets travelling away from source. ✓✓
Elke punt of die golffront dien as 'n bron van sferiese sekondêre golwe of golfies wat weg vanaf die bron beweeg ✓✓ [12.2.1] (2)

9.2 Each point on the initial plane wavefront entering the slit acts as a source of secondary wavelets. ✓ The wavelets propagate in all directions ✓ beyond the slit causing the wave to spread into regions beyond those in line with the slit. ✓
Elke punt op die aanvanklike vlakgolffront wat die spleet binnegaan dien as 'n bron van sekondêre golfies. ✓ *Die golfies word in alle rigtings ✓aan die anderkant van die spleet propageer wat veroorsaak dat die golf in gebiede verder as dié in lyn met die van die spleet, sprei* ✓ [12.2.3] (3)

9.3 $\sin\theta = m\frac{\lambda}{a}$ ✓ $\therefore$ $\sin 15° = 1 \times \frac{650 \times 10^{-9}}{a}$ ✓ $\therefore$ $a = 2,7 \times 10^{-6}$ m ✓ [12.2.3] (3)
[8]

QUESTION 10/*VRAAG 10*

10.1 $C = \frac{\varepsilon_o A}{d}$ ✓ $= \frac{(8,85 \times 10^{-12})(40 \times 10^{-4})}{(0,01)}$ ✓ $= 3,54 \times 10^{-12}$ F

$Q = CV$✓
$= (3,54 \times 10^{-12})(12)$ ✓
$= 4,25 \times 10^{-11}$ C✓ [12.1.3] (5)

10.2 half ✓
Half the area will store half the amount of charge OR C α A ✓
and C α Q, thus C is halved ✓
Helfte✓
Helfte die oppervlak (area) sal die helfte van die aantal lading stoor OF C α A ✓ en C α Q, dus is C halveer ✓ [12.2.2] (3)

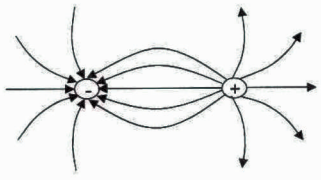
10.3 net charge = 0 C ✓/ *netto lading = 0 C* ✓ [12.2.3] (1)

10.4 Discharges almost instantly to deliver flash light ✓/ *Ontlaai amper onmiddellik om 'n flits te lewer*✓ [12.3.2] (1)
[10]

QUESTION 11/*VRAAG 11*

11.1 (Electric) Force experienced per (positive) charge placed at the point.✓✓
(Elektriese) Krag ondervind per (positiewe) lading geplaas by die punt✓✓ [12.2.1] (2)

11.2



Checklist/*Kontrolelys* Criteria for electric field/*Kriteria vir elektriese veld*	Marks/ *Punte*
Direction *Rigting*	✓
Shape *Vorm*	✓
Field lines not touching each other or entering the spheres *Veldlyne raak nie mekaar nie of wat die sfere binnegaan*	✓

[12.1.2] (3)

11.3 Electric field at P due to Q_1:/*Elektriese veld by P as gevolg van* Q_1

$E = \frac{kQ}{r^2}$ ✓ $= \frac{9\times10^9\times14\times10^{-6}}{1^2}$ ✓= 1,26 x 10^5 N·C^{-1} to the left/*na links*

Electric field at P due to Q_2: *Elektriese veld by P as gevolg van* Q_2

$E = \frac{kQ}{r^2} = \frac{9\times10^9\times20\times10^{-6}}{2^2}$ ✓= 4,5 x 10^4 N·C^{-1} to the left/*na links*

E_{net} = 1,26 x 10^5 + 4,5 x 10^4 N·C^{-1} ✓= 1,71 x 10^5 N·C^{-1} to the left/*na links*✓ [12.1.3] (5)
[10]

QUESTION 12/*VRAAG 12*

12.1 $\frac{1}{R_e} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{1}{9}$ ✓ $+ \frac{1}{23}$ ✓
R = 6,47 Ω ✓

R_{tot} = 6,47 + 2 + 0,2 = 8,67 Ω ✓

$I = \frac{V}{R} = \frac{12}{8,67}$ ✓ = 1,41 A✓ [12.1.3] (6)

12.2 Decreases ✓/*Afneem*

Effective resistance of circuit decreases ✓ (No current through 15 Ω and 8 Ω resistances)
Current increases ✓
Ir (lost volts) increases ✓
$V_{external}$ decreases

Effektiewe weerstand van die stroombaan neem af ✓ *(Geen stroom deur die 15 Ω- en 8 Ω-weerstande)*
Stroom neem toe ✓
Ir (verlore volts) neem toe ✓
$V_{ekstern}$ *neem af* [12.2.2] (4)
[10]

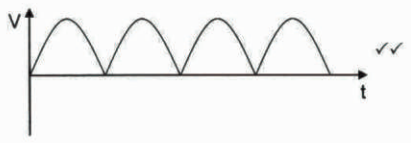
QUESTION 13/*VRAAG 13*

13.1.1 DC ✓ A splitring-commutator ✓ is used to ensure that the current in the loop remains in the same direction through the complete cycle. /
GS✓ */ 'n Spitringkommutator*✓ *word gebruik om te verseker dat die stroom in die spoel in dieselfde rigting bly tydens die volledige siklus.* [12.1.2] (2)

13.1.2 B to A ✓/ *B na A*✓ [12.1.2] (1)

13.1.3 Electromagnetic induction ✓/*Elektromagnetiese induksie*✓ [12.2.1] (1)

13.1.4



[12.1.2] (2)

13.2 When the magnet rotates the changing magnetic flux✓cuts through the windings of the coil ✓and induces a current in the coil. / *Wanneer die magnet roteer sny die veranderende magnetiese vloed* ✓*deur die windings van die spoel*✓ *en induseer 'n stroom in die spoel.* [12.2.3] (2)
[8]

QUESTION 14/*VRAAG 14*

14.1.1 $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ ✓ ∴ $V_{max} = 15(\sqrt{2}) = 21,21$ V ✓ [12.2.3] (2)

14.1.2 R_{total} = 8,2 + 10,4 = 18,6 Ω ✓

$I = \frac{V}{R}$ ✓ $= \frac{15}{18,6}$ ✓= 0,81 A

$P = I^2R$ ✓= $(0,81)^2(10,4)$ ✓= 6,76 W ✓ [12.1.3] (6)

14.2
- With alternating current long distance transmission may be at high voltage and low current, less loss in energy and therefore more energy available for use. ✓/ *Met wisselstroom mag langafstand geleiding teen hoë spanning and lae stroom geskied, minder verlies in energie en daarom meer energie vir verbruik beskikbaar.*✓
- AC allows power stations to be relatively remote from users, so users are isolated from environmental affects of the stations. This remote delivery may save energy elsewhere (e.g. goods transport and commuting). ✓/ *WS maak dit moontlik vir kragstasies om relatief afgeleë van verbruikers te wees, sodoende word verbruikers geïsoleer van die omgewingseffekte van die kragstasies. Hierdie afgeleë lewering mag energie elders bespaar (bv. goederevervoer en pendel)* ✓

[12.3.2] (2)
[10]

QUESTION 15/*VRAAG 15*

15.1 Different metals have different ionisation energies/Different metals attract electrons with different forces. ✓
Verskillende metale het verskillende ionisasie energieë / Verskillende metale trek elektrone aan met verskillende kragte✓ [12.2.1] (1)

15.2 hf = W_0 + ½mv^2 ✓ and/*en* c = fλ ✓

$\frac{hc}{\lambda} = W_0 + \frac{1}{2}mv^2$

$\frac{(6,63\ x10^{-34})(3x10^8)}{(2,3\ x\ 10^{-7})}$ ✓ = W_0 + ½ $(9,11\ x\ 10^{-31})(4,78\ x\ 10^5)^2$ ✓

W_0 = 7,58 x 10^{-19} J✓

Metal X is silver ✓/*Metaal X is silwer*✓ [12.1.3] (6)

15.3 (Establish) particle nature of light ✓/*(Bevestig)die deeltjieaard van lig*✓ [12.2.1] (1)
[8]

TOTAL SECTION B/*TOTAAL AFDELING B:* *115*

GRAND TOTAL/*GROOTTOTAAL:* *150*

SECTION A

Answer this section on the attached ANSWER SHEET.

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) on the attached ANSWER SHEET.

1.1 Atoms, groups of atoms or bonds that give a homologous series its characteristic properties (1)

1.2 A homologous series with the general formula RNH_2 (1)

1.3 The minimum energy required to start a chemical reaction (1)

1.4 The type of electrochemical cell in which electrical energy is converted to chemical energy (1)

1.5 The gas that forms at the positive electrode of a membrane cell (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	A compound that is always present in alcoholic beverages	A	cathode
2.2	An arene	B	reaction rate
2.3	Change in concentration of reactants per unit time	C	CH_3OH
2.4	The electrode in an electrochemical cell where oxidation occurs	D	Na^+
2.5	The ions that migrate through the cell membrane of the membrane cell	E	C_6H_{10}
		F	chemical equilibrium
		G	C_2H_5OH
		H	$C\ell^-$
		I	$C_6H_5(CH_3)$
		J	anode

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 Ketones contain a carbonyl group. (2)

3.2 Some catalysts can speed up a chemical reaction by providing a new, lower energy pathway. (2)

3.3 The equilibrium constant for an exothermic reaction decreases with increase in temperature. (2)

3.4 The standard conditions used to measure standard electrode potentials are:

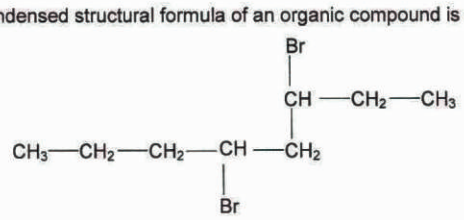
- A temperature of 273 K
- A concentration of 1 mol·dm^{-3}
- A pressure of 101,3 kPa (2)

3.5 A primary cell can be recharged. (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 The condensed structural formula of an organic compound is shown below:



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

A 4,6-dibromooctane
B 4-bromo-5-bromo-5-propylpentane
C 3,5-dibromooctane
D 2-bromo-1-bromo-1-propylpentane (3)

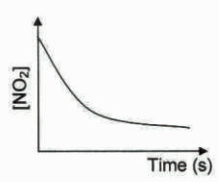
4.2 $N_2O_4(g)$ is placed in an evacuated, sealed container.

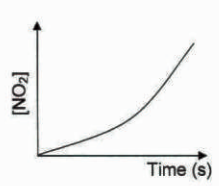
The following reaction takes place in the container at constant temperature:

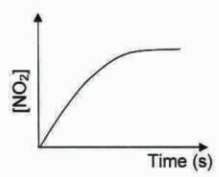
$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

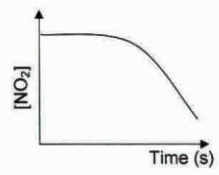
The concentration of the product is measured over time.

Which ONE of the following graphs correctly illustrates the relationship between the nitrogen dioxide (NO_2) concentration and time?

A


B


C


D


(3)

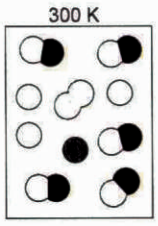
4.3 The following hypothetical reaction is at equilibrium at 300 K:

$$A_2(g) + B(g) \rightleftharpoons A(g) + AB(g)$$

The diagram below shows the molecules involved in this chemical equilibrium at 300 K.

The white circles represent atoms of A and the black circles represent atoms of B.

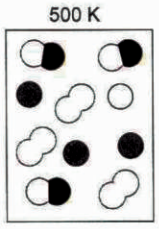
300 K



The temperature is increased to 500 K.

The diagram below represents the same equilibrium mixture at 500 K.

500 K



Which ONE of the following statements is CORRECT?

A The forward reaction is exothermic.
B The concentration of AB is lower at a lower temperature.
C The forward reaction is endothermic.
D The concentration of B is higher at a lower temperature. (3)

4.4 The most common filling for tooth cavities is 'dental amalgam' – a solid solution of tin and silver in mercury. If you bite on a piece of aluminium foil that is in contact with a dental filling in your mouth, you may feel a painful sensation because ...

A the aluminium foil is hard.

B a temporary galvanic cell has been set up whilst the aluminium and fill are in contact.

C electrons are being transferred to the aluminium.

D a temporary electrolytic cell has been set up whilst the aluminium and fill are in contact. (3)

4.5 Eutrophication in water is caused by ...

A algal bloom.

B a depletion of oxygen concentration.

C bacterial nitrogen fixation.

D an increase in plant nutrients. (3)
[15]

TOTAL SECTION A: 35

SECTION B

INSTRUCTIONS

1. Answer this section in the ANSWER BOOK.
2. In ALL calculations the formulae and substitutions must be shown.
3. Round off your answers to TWO decimal places where applicable.

QUESTION 5

There are two structural isomers for the organic compound with molecular formula $C_2H_4O_2$.

5.1 Define the term *structural isomer*. (2)

5.2 Write down the structural formula of these two isomers and next to each its IUPAC name. (3 x 2) (6)

5.3 State with reason which ONE of these isomers:

5.3.1 Has the higher boiling point (3)

5.3.2 Has the higher vapour pressure (3)

5.4 Will the vapour pressure of carboxylic acids increase or decrease if the number of carbon atoms in the chain increases? Give a reason for your answer. (3)
[17]

QUESTION 6

Rubber is a naturally occurring compound. The diene, 2-methyl-1,3-butadiene, is one of the repeating units found in rubber.

Over 20 million families depend on rubber cultivation for their livelihood. Tens of thousands of hectares of tropical forests have been cleared to make way for rubber plantations.

Chemists have been able to combine other dienes to obtain synthetic rubbers. Some rubber products include latex products such as hand gloves, raincoats and other products used in the battle against HIV/Aids.

The world's largest use of rubber is in tyres, and most tyres contain both natural rubber, which withstands heat better, and one or more kinds of synthetic rubber.

6.1 Is 2-methyl-1,3-butadiene an example of a saturated or an unsaturated hydrocarbon? Give a reason for your answer. (3)

6.2 Write down the structural formula of 2-methyl-1,3-butadiene. (2)

6.3 With regard to the environment, name TWO disadvantages of rubber and the production of rubber. (2)

6.4 With regard to human life, name TWO benefits of rubber and the production of rubber. (2)
[9]

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.

Reaction I: $CH_3—CH_2—CH=CH_2 + H_2O \longrightarrow$

Reaction II: $CH_3CH_2\,CH_2—C(CH_3)=CH_2 + HBr \longrightarrow$

Reaction III: $CH_3CH(OH)\,CH_2CH_3 \xrightarrow[\text{heat}]{H_2SO_4}$

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 8

Antacids are used to relieve indigestion. Indigestion is the condition when the stomach produces too much acid resulting in an uncomfortable and painful feeling. A certain antacid tablet dissolves in water and reacts with the acid in the stomach to release carbon dioxide gas.

8.1 Name the type of chemical reaction that explains why antacids bring relief from indigestion. (1)

8.2 A group of learners wants to investigate the effect of temperature on the rate of dissolution of this antacid tablet in water.

Design an investigation that the group of learners can conduct by answering the questions below.

8.2.1 State an investigative question. (2)

8.2.2 State a hypothesis for this investigation. (2)

8.2.3 Write down a procedure that can be followed in this investigation to test your hypothesis using some or all of the apparatus/chemicals listed below:

- Thermometer
- Stopwatch
- Hot plate
- Beaker
- Measuring cylinder
- Spatula/Teaspoon
- Water
- Antacid tablet (4)

8.2.4 Draw a table that can be used to record the results. Indicate the relevant headings of the rows and columns in the table. No values (numerical data) are required. (4)

8.3 Is it better to take the antacid tablet with warm water or with cold water? Give a reason for your answer. (2)
[15]

QUESTION 9

Smog refers to a very unpleasant condition of pollution in certain urban environments. It is produced largely by the action of sunlight on car exhaust gases. Two groups of compounds emitted from car exhausts, that contribute to the formation of smog, are nitrogen oxides and unburned hydrocarbons.

Nitric oxide (NO(g)) forms in internal combustion engines by the direct combination of nitrogen and oxygen according to the following reversible reaction:

$$N_2(g) + O_2(g) \rightleftharpoons 2\,NO(g) \qquad \Delta H = +90{,}4\ kJ$$

In air, nitric oxide is rapidly oxidised to nitrogen dioxide ($NO_2(g)$) that initiates the reactions responsible for the formation of smog. Nitrogen dioxide acts as catalyst for the formation of ozone, a key component of smog.

Although an essential UV screen in the upper atmosphere, ozone is an undesirable pollutant in the lower atmosphere. It is extremely reactive and toxic, and breathing air containing appreciable amounts of ozone can be dangerous for asthma sufferers, sports people and the elderly.

9.1 Before the Olympic Games in Beijing, authorities were extremely concerned about the levels of smog in the city.
Explain why high smog levels are especially dangerous for sports people. (2)

9.2 Suggest TWO ways of reducing NO(g) in urban areas. (2)

The questions below refer to the reaction in the passage above.

9.3 Explain why the formation of NO(g) is favoured in internal combustion engines where temperatures are as high as 2 400 K. (2)

9.4 During a research experiment carried out by initially adding 1 mol of $O_2(g)$ and 1 mol of $N_2(g)$ in a 2 dm^3 closed container at 300 K, it was found that the concentration of the NO(g) present in the container at equilibrium was 0,1 $mol{\cdot}dm^{-3}$.

Calculate the equilibrium constant (K_c) for the reaction at this temperature. (7)

9.5 How will the amount of NO(g) at equilibrium be affected if:

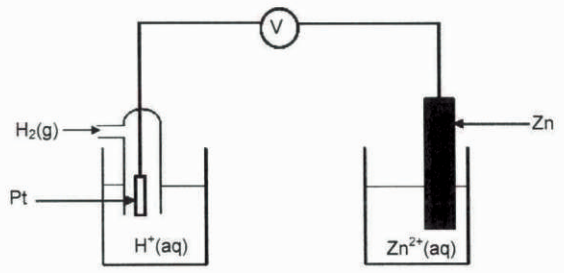
9.5.1 The pressure is increased by decreasing the volume (2)

9.5.2 A catalyst is added (1)

9.6 Draw the potential energy diagram for the above reaction. Indicate the heat of reaction and the activation energy for the catalysed reaction on the diagram. (5)
[21]

QUESTION 10

The discovery of electrochemical cells has revolutionised our way of life. The diagram below represents an electrochemical cell.



10.1 Name the type of electrochemical cell that converts chemical energy to electrical energy. (1)

10.2 If the electrochemical cell is set up as illustrated, there will be no reading on the voltmeter. Give a reason for this observation. (1)

10.3 Write down the value of the standard emf of the electrochemical cell when it is functioning. (1)

10.4 Write down the voltmeter reading when the net cell reaction in the above electrochemical cell reaches equilibrium. (1)

10.5 Write down the equation for the reaction that occurs at the anode. (2)

10.6 Another electrochemical cell is set up under standard conditions by replacing the standard hydrogen half-cell with a standard magnesium half-cell.

10.6.1 Which electrode will undergo a decrease in mass? Give a reason for your answer. (2)

10.6.2 Calculate the initial emf of this electrochemical cell at standard conditions. (4)

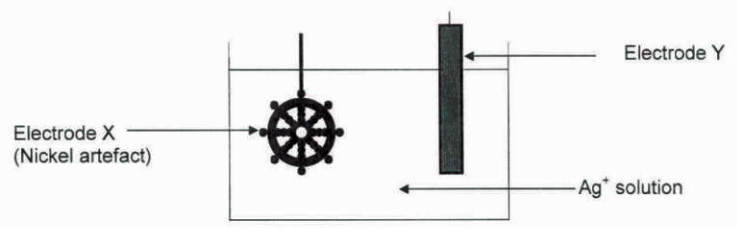
10.6.3 After a while the emf of this electrochemical cell decreases. Explain this observation by referring to the concentration of the electrolytes. (2)

10.7 Electrochemical cells such as motor car batteries with plastic casings can harm the environment if not disposed of safely. Suggest TWO ways how motor car batteries can be safely disposed of. (2)
[16]

QUESTION 11

An attractive silver appearance can be created by electroplating artefacts made from cheaper metals, such as nickel, with silver.

The simplified diagram below represents an arrangement that can be used to electroplate a nickel artefact with silver.



11.1 Which electrode (cathode/anode) will the nickel artefact represent? (1)

11.2 Name the metal represented by electrode Y. (1)

11.3 Write down the half-reaction responsible for the change that occurs at the surface of the artefact. (2)

11.4 Give a reason why the concentration of the electrolyte remains constant during electroplating. (2)

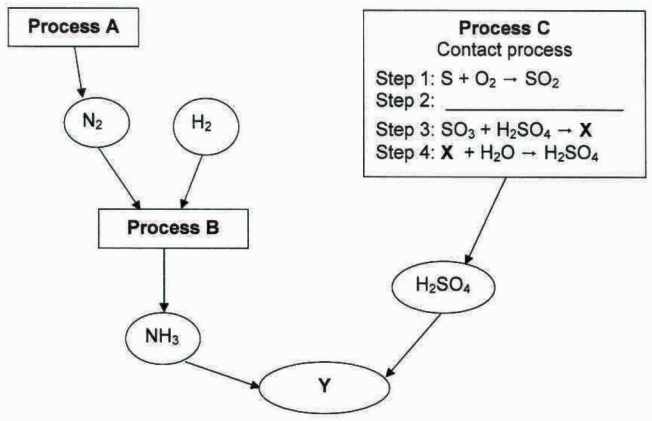
11.5 In industry some plastic articles are sometimes electroplated. Explain why plastic must be coated with graphite before electroplating. (2)

11.6 Give a reason why, from a business point of view, it is not advisable to plate platinum with silver. (1)
[9]

Physical Sciences: Chemistry P2
February/March 2009

QUESTION 12

About one third of the protein consumed by humans comes from fertilisers. The flow diagram below shows three industrial processes, A, B and C, that result in the production of fertilisers.



12.1 Write down the name of the Process A. (1)

12.2 Write down the balanced equation for the reaction which takes place in process B. (3)

12.3 Write down the balanced equation for step 2 of Process C. (3)

12.4 Write down the FORMULA and the NAME of product X in step 3 of Process C. (2)

12.5 Write the FORMULA and the NAME of the fertiliser represented by **Y**. (3)

12.6 Fertiliser prices increased by more than 200 per cent since 2007. This rise is fuelled by new demand.

12.6.1 Give TWO reasons why there is a continuous demand for fertilisers. (2)

12.6.2 Give TWO reasons why there is an increase in the price of fertilisers. (2)
[16]

TOTAL SECTION B: 115

GRAND TOTAL: 150

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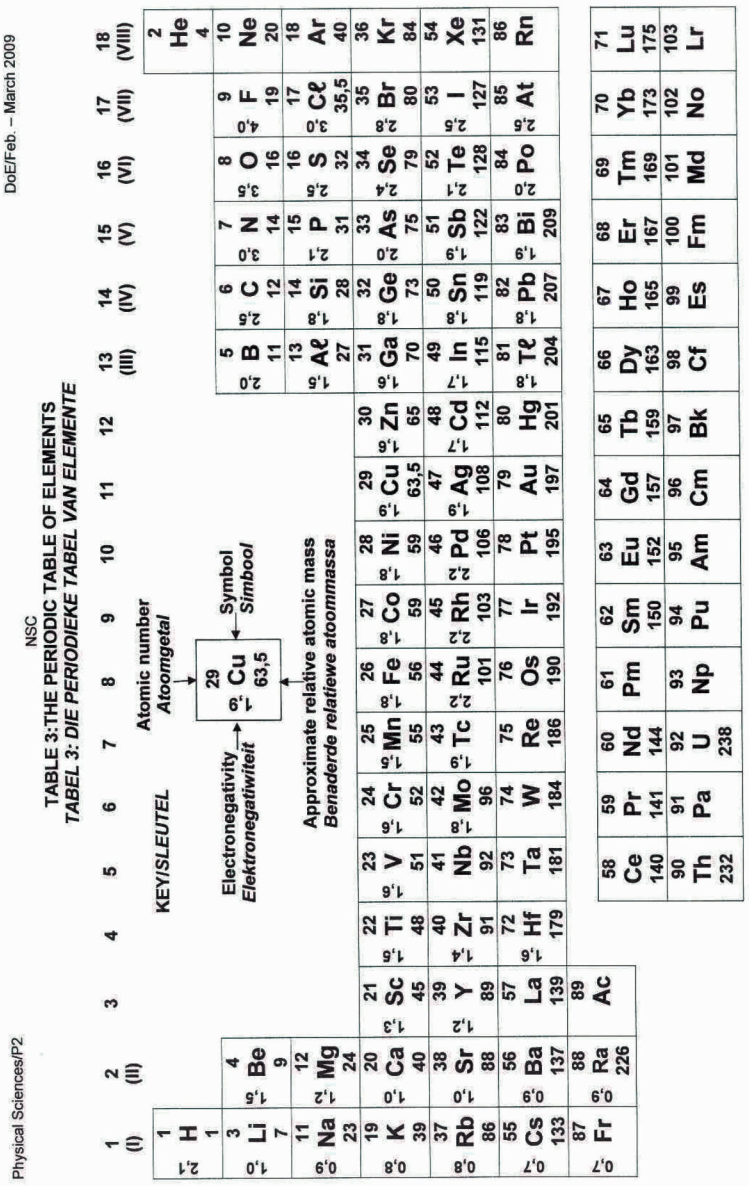
TABLE 3:THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE



NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$c = \frac{n}{V}$
$c = \frac{m}{MV}$	$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$

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

Half-reactions/*Halfreaksies*	E^θ (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
$\mathbf{2H^+ + 2e^- \rightleftharpoons H_2(g)}$	**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 oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

Half-reactions/*Halfreaksies*	E^{θ} (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
$Al^{3+} + 3e^- \rightleftharpoons Al$	− 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
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 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

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EXAMINATION NUMBER: _____

PHYSICAL SCIENCES P2 GRADE 12 ANSWER SHEET
FISIESE WETENSKAPPE V2 GRAAD 12-ANTWOORDBLAD

QUESTION 1/*VRAAG 1*

1.1 _____ (1)
1.2 _____ (1)
1.3 _____ (1)
1.4 _____ (1)
1.5 _____ (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 _____ (1)
2.2 _____ (1)
2.3 _____ (1)
2.4 _____ (1)
2.5 _____ (1)
[5]

QUESTION 3/*VRAAG 3*

3.1 _____
_____ (2)
3.2 _____
_____ (2)
3.3 _____
_____ (2)
3.4 _____
_____ (2)
3.5 _____
_____ (2)
[10]

QUESTION 4/*VRAAG 4*

4.1	A	B	C	D
4.2	A	B	C	D
4.3	A	B	C	D
4.4	A	B	C	D
4.5	A	B	C	D

(5 x 3) [15]

TOTAL SECTION A/*TOTAAL AFDELING A:* 35

Physical Sciences : Chemistry P2
February/March 2009

INSTRUCTIONS AND INFORMATION

1. Write your examination number (and centre number if applicable) in the appropriate spaces on the ANSWER BOOK and ANSWER SHEET.
2. Answer ALL the questions.
3. This question paper consists of TWO sections:

   SECTION A (35 marks)
   SECTION B (115 marks)
4. Answer SECTION A on the attached ANSWER SHEET.
5. Answer SECTION B in the ANSWER BOOK.
6. Non-programmable calculators may be used.
7. Appropriate mathematical instruments may be used.
8. Number the answers correctly according to the numbering system used in this question paper.
9. Data sheets are attached for your use.
10. Wherever motivations, discussions, et cetera are required, be brief.

SECTION A

Answer this section on the attached ANSWER SHEET.

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) on the attached ANSWER SHEET.

1.1 Atoms, groups of atoms or bonds that give a homologous series its characteristic properties (1)

1.2 A homologous series with the general formula RNH_2 (1)

1.3 The minimum energy required to start a chemical reaction (1)

1.4 The type of electrochemical cell in which electrical energy is converted to chemical energy (1)

1.5 The gas that forms at the positive electrode of a membrane cell (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	A compound that is always present in alcoholic beverages	A	cathode
2.2	An arene	B	reaction rate
2.3	Change in concentration of reactants per unit time	C	CH_3OH
2.4	The electrode in an electrochemical cell where oxidation occurs	D	Na^+
2.5	The ions that migrate through the cell membrane of the membrane cell	E	C_6H_{10}
		F	chemical equilibrium
		G	C_2H_5OH
		H	$C\ell^-$
		I	$C_6H_5(CH_3)$
		J	anode

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 Ketones contain a carbonyl group. (2)

3.2 Some catalysts can speed up a chemical reaction by providing a new, lower energy pathway. (2)

3.3 The equilibrium constant for an exothermic reaction decreases with increase in temperature. (2)

3.4 The standard conditions used to measure standard electrode potentials are:

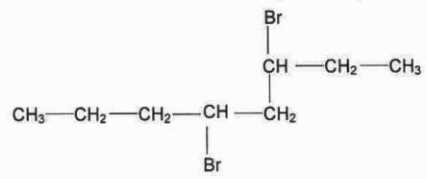
- A temperature of 273 K
- A concentration of 1 $mol{\cdot}dm^{-3}$
- A pressure of 101,3 kPa (2)

3.5 A primary cell can be recharged. (2)
[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 The condensed structural formula of an organic compound is shown below:



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

A 4,6-dibromooctane
B 4-bromo-5-bromo-5-propylpentane
C 3,5-dibromooctane
D 2-bromo-1-bromo-1-propylpentane (3)

4.2 $N_2O_4(g)$ is placed in an evacuated, sealed container.

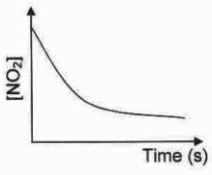
The following reaction takes place in the container at constant temperature:

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

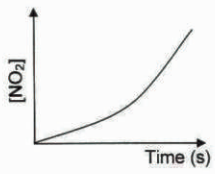
The concentration of the product is measured over time.

Which ONE of the following graphs correctly illustrates the relationship between the nitrogen dioxide (NO_2) concentration and time?

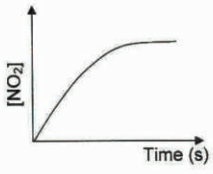
A



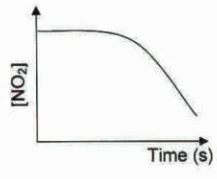
B



C



D



(3)

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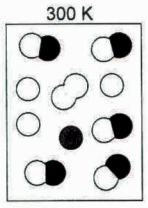
4.3 The following hypothetical reaction is at equilibrium at 300 K:

$$A_2(g) + B(g) \rightleftharpoons A(g) + AB(g)$$

The diagram below shows the molecules involved in this chemical equilibrium at 300 K.

The white circles represent atoms of A and the black circles represent atoms of B.

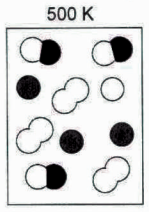
300 K



The temperature is increased to 500 K.

The diagram below represents the same equilibrium mixture at 500 K.

500 K



Which ONE of the following statements is CORRECT?

A The forward reaction is exothermic.
B The concentration of AB is lower at a lower temperature.
C The forward reaction is endothermic.
D The concentration of B is higher at a lower temperature. (3)

4.4 The most common filling for tooth cavities is 'dental amalgam' – a solid solution of tin and silver in mercury. If you bite on a piece of aluminium foil that is in contact with a dental filling in your mouth, you may feel a painful sensation because …

A the aluminium foil is hard.

B a temporary galvanic cell has been set up whilst the aluminium and fill are in contact.

C electrons are being transferred to the aluminium.

D a temporary electrolytic cell has been set up whilst the aluminium and fill are in contact. (3)

4.5 Eutrophication in water is caused by …

A algal bloom.

B a depletion of oxygen concentration.

C bacterial nitrogen fixation.

D an increase in plant nutrients. (3)
[15]

TOTAL SECTION A: 35

SECTION B

INSTRUCTIONS

1. Answer this section in the ANSWER BOOK.
2. In ALL calculations the formulae and substitutions must be shown.
3. Round off your answers to TWO decimal places where applicable.

QUESTION 5

There are two structural isomers for the organic compound with molecular formula $C_2H_4O_2$.

5.1 Define the term *structural isomer*. (2)

5.2 Write down the structural formula of these two isomers and next to each its IUPAC name. (3 x 2) (6)

5.3 State with reason which ONE of these isomers:

5.3.1 Has the higher boiling point (3)

5.3.2 Has the higher vapour pressure (3)

5.4 Will the vapour pressure of carboxylic acids increase or decrease if the number of carbon atoms in the chain increases? Give a reason for your answer. (3)
[17]

QUESTION 6

Rubber is a naturally occurring compound. The diene, 2-methyl-1,3-butadiene, is one of the repeating units found in rubber.

Over 20 million families depend on rubber cultivation for their livelihood. Tens of thousands of hectares of tropical forests have been cleared to make way for rubber plantations.

Chemists have been able to combine other dienes to obtain synthetic rubbers. Some rubber products include latex products such as hand gloves, raincoats and other products used in the battle against HIV/Aids.

The world's largest use of rubber is in tyres, and most tyres contain both natural rubber, which withstands heat better, and one or more kinds of synthetic rubber.

6.1 Is 2-methyl-1,3-butadiene an example of a saturated or an unsaturated hydrocarbon? Give a reason for your answer. (3)

6.2 Write down the structural formula of 2-methyl-1,3-butadiene. (2)

6.3 With regard to the environment, name TWO disadvantages of rubber and the production of rubber. (2)

6.4 With regard to human life, name TWO benefits of rubber and the production of rubber. (2)
[9]

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.

Reaction I: $CH_3—CH_2—CH=CH_2 + H_2O \longrightarrow$

Reaction II: $CH_3CH_2CH_2—C(CH_3)=CH_2 + HBr \longrightarrow$

Reaction III: $CH_3CH(OH)CH_2CH_3 \xrightarrow[\text{heat}]{H_2SO_4}$

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 8

Antacids are used to relieve indigestion. Indigestion is the condition when the stomach produces too much acid resulting in an uncomfortable and painful feeling. A certain antacid tablet dissolves in water and reacts with the acid in the stomach to release carbon dioxide gas.

8.1 Name the type of chemical reaction that explains why antacids bring relief from indigestion. (1)

8.2 A group of learners wants to investigate the effect of temperature on the rate of dissolution of this antacid tablet in water.

Design an investigation that the group of learners can conduct by answering the questions below.

8.2.1 State an investigative question. (2)

8.2.2 State a hypothesis for this investigation. (2)

8.2.3 Write down a procedure that can be followed in this investigation to test your hypothesis using some or all of the apparatus/chemicals listed below:

- Thermometer
- Stopwatch
- Hot plate
- Beaker
- Measuring cylinder
- Spatula/Teaspoon
- Water
- Antacid tablet (4)

8.2.4 Draw a table that can be used to record the results. Indicate the relevant headings of the rows and columns in the table. No values (numerical data) are required. (4)

8.3 Is it better to take the antacid tablet with warm water or with cold water? Give a reason for your answer. (2)
[15]

QUESTION 9

Smog refers to a very unpleasant condition of pollution in certain urban environments. It is produced largely by the action of sunlight on car exhaust gases. Two groups of compounds emitted from car exhausts, that contribute to the formation of smog, are nitrogen oxides and unburned hydrocarbons.

Nitric oxide (NO(g)) forms in internal combustion engines by the direct combination of nitrogen and oxygen according to the following reversible reaction:

$$N_2(g) + O_2(g) \rightleftharpoons 2\,NO(g) \qquad \Delta H = +90{,}4\ kJ$$

In air, nitric oxide is rapidly oxidised to nitrogen dioxide ($NO_2(g)$) that initiates the reactions responsible for the formation of smog. Nitrogen dioxide acts as catalyst for the formation of ozone, a key component of smog.

Although an essential UV screen in the upper atmosphere, ozone is an undesirable pollutant in the lower atmosphere. It is extremely reactive and toxic, and breathing air containing appreciable amounts of ozone can be dangerous for asthma sufferers, sports people and the elderly.

9.1 Before the Olympic Games in Beijing, authorities were extremely concerned about the levels of smog in the city.
Explain why high smog levels are especially dangerous for sports people. (2)

9.2 Suggest TWO ways of reducing NO(g) in urban areas. (2)

The questions below refer to the reaction in the passage above.

9.3 Explain why the formation of NO(g) is favoured in internal combustion engines where temperatures are as high as 2 400 K. (2)

9.4 During a research experiment carried out by initially adding 1 mol of $O_2(g)$ and 1 mol of $N_2(g)$ in a 2 dm^3 closed container at 300 K, it was found that the concentration of the NO(g) present in the container at equilibrium was 0,1 $mol{\cdot}dm^{-3}$.

Calculate the equilibrium constant (K_c) for the reaction at this temperature. (7)

9.5 How will the amount of NO(g) at equilibrium be affected if:

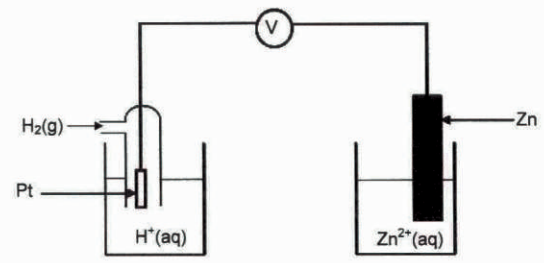
9.5.1 The pressure is increased by decreasing the volume (2)

9.5.2 A catalyst is added (1)

9.6 Draw the potential energy diagram for the above reaction. Indicate the heat of reaction and the activation energy for the catalysed reaction on the diagram. (5)
[21]

QUESTION 10

The discovery of electrochemical cells has revolutionised our way of life. The diagram below represents an electrochemical cell.



10.1 Name the type of electrochemical cell that converts chemical energy to electrical energy. (1)

10.2 If the electrochemical cell is set up as illustrated, there will be no reading on the voltmeter. Give a reason for this observation. (1)

10.3 Write down the value of the standard emf of the electrochemical cell when it is functioning. (1)

10.4 Write down the voltmeter reading when the net cell reaction in the above electrochemical cell reaches equilibrium. (1)

10.5 Write down the equation for the reaction that occurs at the anode. (2)

10.6 Another electrochemical cell is set up under standard conditions by replacing the standard hydrogen half-cell with a standard magnesium half-cell.

10.6.1 Which electrode will undergo a decrease in mass? Give a reason for your answer. (2)

10.6.2 Calculate the initial emf of this electrochemical cell at standard conditions. (4)

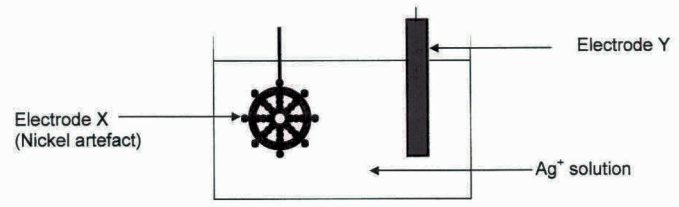
10.6.3 After a while the emf of this electrochemical cell decreases. Explain this observation by referring to the concentration of the electrolytes. (2)

10.7 Electrochemical cells such as motor car batteries with plastic casings can harm the environment if not disposed of safely. Suggest TWO ways how motor car batteries can be safely disposed of. (2)
[16]

QUESTION 11

An attractive silver appearance can be created by electroplating artefacts made from cheaper metals, such as nickel, with silver.

The simplified diagram below represents an arrangement that can be used to electroplate a nickel artefact with silver.



11.1 Which electrode (cathode/anode) will the nickel artefact represent? (1)

11.2 Name the metal represented by electrode Y. (1)

11.3 Write down the half-reaction responsible for the change that occurs at the surface of the artefact. (2)

11.4 Give a reason why the concentration of the electrolyte remains constant during electroplating. (2)

11.5 In industry some plastic articles are sometimes electroplated. Explain why plastic must be coated with graphite before electroplating. (2)

11.6 Give a reason why, from a business point of view, it is not advisable to plate platinum with silver. (1)
[9]

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

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*

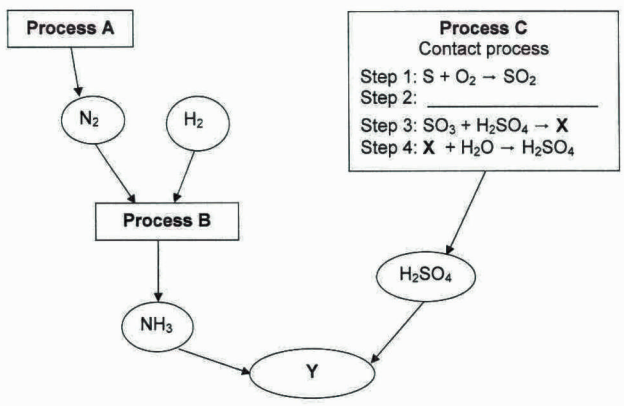
NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$c = \frac{n}{V}$
$c = \frac{m}{MV}$	$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$

QUESTION 12

About one third of the protein consumed by humans comes from fertilisers. The flow diagram below shows three industrial processes, A, B and C, that result in the production of fertilisers.



12.1 Write down the name of the Process A. (1)

12.2 Write down the balanced equation for the reaction which takes place in process B. (3)

12.3 Write down the balanced equation for step 2 of Process C. (3)

12.4 Write down the FORMULA and the NAME of product X in step 3 of Process C. (2)

12.5 Write the FORMULA and the NAME of the fertiliser represented by **Y**. (3)

12.6 Fertiliser prices increased by more than 200 per cent since 2007. This rise is fuelled by new demand.

12.6.1 Give TWO reasons why there is a continuous demand for fertilisers. (2)

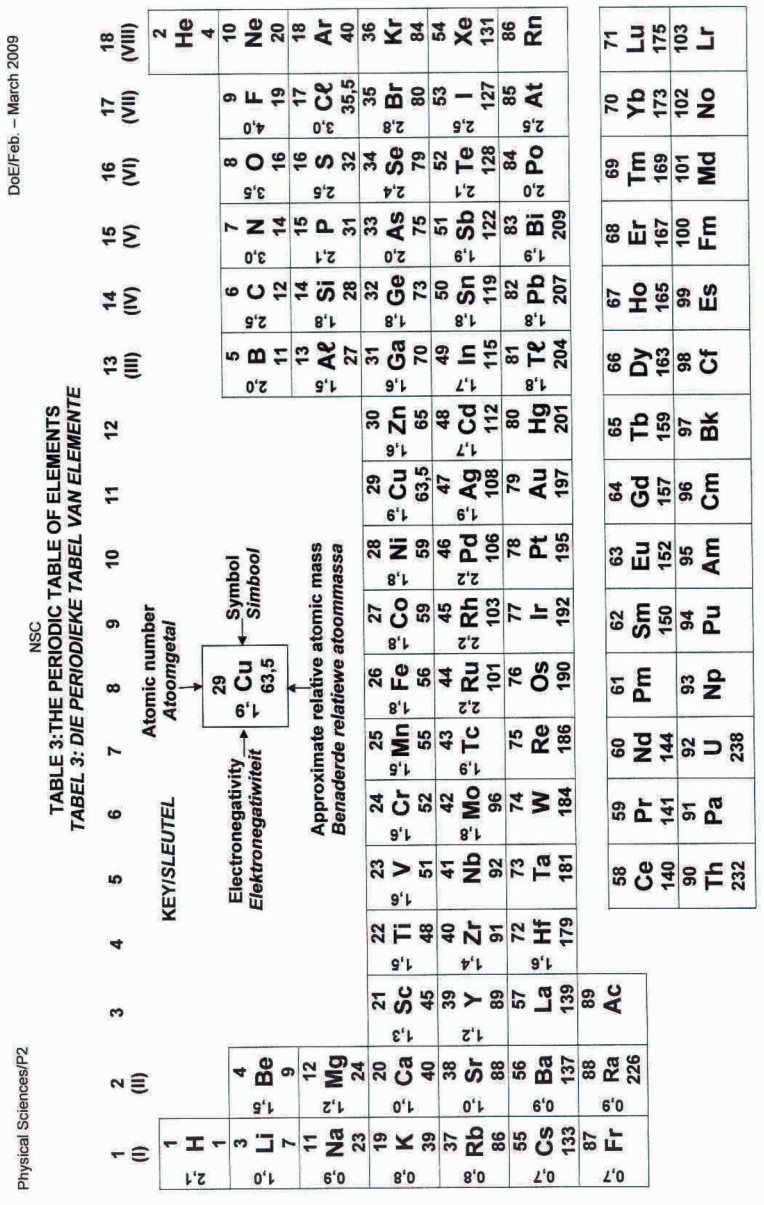
12.6.2 Give TWO reasons why there is an increase in the price of fertilisers. (2)
[16]

TOTAL SECTION B: 115

GRAND TOTAL: 150

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

NSC



Physical Sciences/P2

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

Half-reactions/*Halfreaksies*	E^θ (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 oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

EXAMINATION NUMBER: _____

PHYSICAL SCIENCES P2 GRADE 12 ANSWER SHEET
FISIESE WETENSKAPPE V2 GRAAD 12-ANTWOORDBLAD

QUESTION 1/*VRAAG 1*

1.1 _____ (1)
1.2 _____ (1)
1.3 _____ (1)
1.4 _____ (1)
1.5 _____ (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 _____ (1)
2.2 _____ (1)
2.3 _____ (1)
2.4 _____ (1)
2.5 _____ (1)
[5]

QUESTION 3/*VRAAG 3*

3.1 _____
_____ (2)
3.2 _____
_____ (2)
3.3 _____
_____ (2)
3.4 _____
_____ (2)
3.5 _____
_____ (2)
[10]

QUESTION 4/*VRAAG 4*

4.1	A	B	C	D
4.2	A	B	C	D
4.3	A	B	C	D
4.4	A	B	C	D
4.5	A	B	C	D

(5 x 3) [15]

TOTAL SECTION A/*TOTAAL AFDELING A:* 35

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

Half-reactions/*Halfreaksies*	E^θ (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 oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

Physical Sciences :Chemistry P2
November 2009 (1)

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the spaces on the ANSWER BOOK.
2. Answer ALL the questions.
3. This question paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)
4. Answer SECTION A and SECTION B in the ANSWER BOOK.
5. Non-programmable calculators may be used.
6. Appropriate mathematical instruments may be used.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Data sheets and a periodic table are attached for your use.
9. Give brief motivations, discussions, et cetera where required.

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 reaction type that can be used to convert hydrocarbons with high molecular masses to hydrocarbons with low molecular masses (1)

1.2 The theory that explains why an increase in temperature results in an increase in reaction rate (1)

1.3 The minimum energy needed for a reaction to take place (1)

1.4 A substance that shows a decrease in oxidation number during chemical reactions (1)

1.5 The process which can lead to dead zones in a dam or lake (1)
[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Correct each statement so that it is TRUE. Write down only the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example "... IS NOT ...", will not be accepted.

2.1 Ethanol is an example of a secondary alcohol that is completely soluble in water. (2)

2.2 The chlorination of methane is an addition reaction. (2)

2.3 A catalyst increases the yield (amount) of products in a chemical reaction. (2)

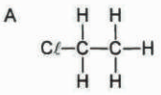
2.4 During electroplating of a steel teaspoon with silver, the teaspoon is the cathode and the electrolyte is a solution of any soluble compound. (2)

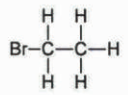
2.5 Nitrogen, phosphorus and potassium are the three essential nutrients needed by plants. (2)
[10]

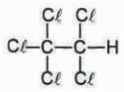
QUESTION 3: MULTIPLE-CHOICE QUESTIONS

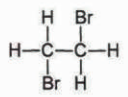
Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (3.1 – 3.5) in the ANSWER BOOK.

3.1 Which ONE of the following compounds has structural isomers?

A 

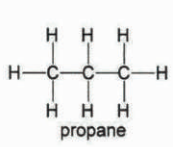
B 

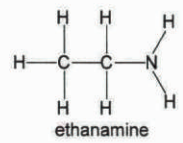
C 

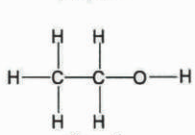
D 

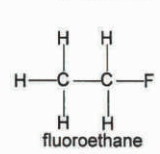
(2)

3.2 Consider the structural formula and IUPAC name of each compound shown below.


propane


ethanamine


ethanol


fluoroethane

Which ONE of these compounds has the highest vapour pressure at room temperature?

A Propane
B Ethanamine
C Ethanol
D Fluoroethane (2)

3.3 Diagrams P, Q and R represent different reaction mixtures of the following hypothetical reaction that is at equilibrium in a closed container at a certain temperature.

$X(g) + Y_2(g) \rightleftharpoons XY(g) + Y(g) \qquad \Delta H > 0$

KEY X: ◯ Y: ●

Diagram P

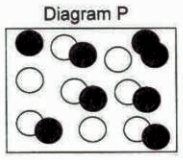


Diagram Q

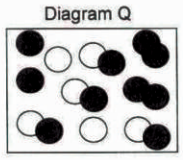
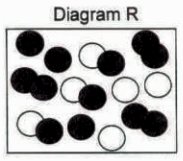


Diagram R



If at equilibrium $K_c = 2$, which diagram(s) correctly represent(s) the mixture at equilibrium?

A P only
B Q only
C R only
D P, R and Q (2)

3.4 The reactions below occur in two different electrochemical cells X and Y.

Cell X: $CuC\ell_2(aq) \rightarrow Cu(s) + C\ell_2(g)$

Cell Y: $Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$

Which ONE of the following correctly describes the substance that forms at the CATHODE of each of these cells?

	Cell X	Cell Y
A	$C\ell_2(g)$	Cu(s)
B	Cu(s)	Cu(s)
C	$C\ell_2(g)$	$ZnSO_4(aq)$
D	Cu(s)	$ZnSO_4(aq)$

(2)

3.5 Which ONE of the following correctly describes the initial product(s) formed during the industrial fixation of nitrogen?

A Ammonia
B Ammonium nitrate
C Nitrogen dioxide
D Nitrogen and hydrogen (2)
[10]

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 4.1 and QUESTION 4.2.
3. The formulae and substitutions must be shown in ALL calculations.
4. Round off your answers to TWO decimal places where applicable.

QUESTION 4 (Start on a new page.)

Both esters and amides are considered derivatives of carboxylic acids and can be prepared by using carboxylic acids as one of the reactants.

Esters are known for their pleasant smells. Amides are the building blocks of proteins.

4.1 Write down the structural formula for the functional group of a primary amide. (1)

4.2 An ester with six carbon atoms is prepared using propanoic acid as one of the reactants.

4.2.1 Use structural formulae to write a balanced equation for the preparation of this ester. (6)

4.2.2 Write down the IUPAC name of this ester. (1)

4.2.3 Write down the name of the catalyst needed for this preparation. (1)

4.3 A certain amide has three carbon atoms in its stem (the carbon chain containing the carbonyl group). If the nitrogen atom of this amide has a methyl and an ethyl substituent, write down the amide's:

4.3.1 Structural formula (2)

4.3.2 IUPAC name (1)
[12]

QUESTION 5 (Start on a new page.)

The table below shows the results obtained during a practical investigation. Two experiments were performed to determine the boiling points of compounds from three different homologous series under the same conditions. Each letter A to F represents the organic compound written in the block next to it.

Experiment	Organic compound		Molar mass ($g \cdot mol^{-1}$)	Boiling point (°C)
I	**A**	CH_3COOH	60,5	118
	B	$CH_3CH_2CH_2OH$	60,1	97
	C	CH_3CH_2CHO	58,1	48
II	**D**	$CH_3(CH_2)_2COOH$	88,1	163
	E	$CH_3(CH_2)_3CH_2OH$	88,1	137
	F	$CH_3(CH_2)_3CHO$	88,1	103

5.1 Name the homologous series to which each of the following pairs of compounds belong:

5.1.1 A and D (1)

5.1.2 B and E (1)

5.1.3 C and F (1)

5.2 Write down the IUPAC name for:

5.2.1 Compound C (1)

5.2.2 Compound E (1)

5.3 Formulate an investigative question for this practical investigation. (2)

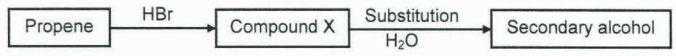
5.4 Which other variable, apart from the conditions for determining boiling points, was kept constant? (1)

5.5 What conclusion can be drawn from the results in Experiment II? (2)

5.6 Refer to intermolecular forces to explain the trend in boiling points, as shown in the table. (3)
[13]

QUESTION 6 (Start on a new page.)

The flow diagram below shows the conversion of propene to a secondary alcohol.



6.1 Give a reason why propene is classified as an unsaturated organic compound. (1)

6.2 Use structural formulae to write a balanced equation for the formation of compound X. (4)

6.3 Name the type of reaction that takes place when propene is converted to compound X. (1)

6.4 Write down the structural formula and IUPAC name for the secondary alcohol that is formed. (3)

6.5 Name the type of substitution reaction that takes place when compound X is converted to the secondary alcohol. (1)

6.6 With the aid of a catalyst, propene can be converted directly to the secondary alcohol, without the formation of the intermediate compound X.

6.6.1 Besides propene, write down the NAME of the reactant needed for this direct conversion. (1)

6.6.2 Write down the FORMULA of a catalyst that can be used. (1)

6.6.3 Name the type of reaction that will take place during this direct conversion. (1)

6.7 Instead of adding water to compound X, concentrated sodium hydroxide is added and the mixture is heated.

6.7.1 Write down the IUPAC name of the organic product that is formed. (1)

6.7.2 Name the type of reaction that takes place. (1)
[15]

QUESTION 7 (Start on a new page.)

A group of learners use the reaction between hydrochloric acid and magnesium powder to investigate one of the factors that influence the rate of a chemical reaction. The reaction that takes place is:

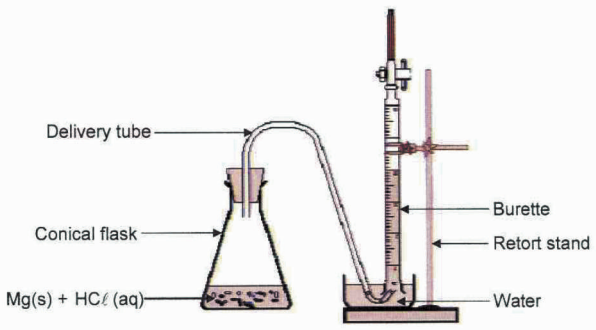
$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

The learners use the apparatus and follow the method shown below to conduct the investigation.

Method – Experiment 1:
Step 1: Place a spatula of magnesium powder in a conical flask and add 50 cm^3 $HC\ell$ (aq) of known concentration.
Step 2: Simultaneously start the stopwatch and close the flask with the rubber stopper containing the delivery tube.
Step 3: Measure the volume of the $H_2(g)$ formed in time intervals of 20 seconds.

Method – Experiment 2:
Repeat steps 1 to 3 above, but use only 25 cm^3 of the same $HC\ell$ (aq) diluted to 50 cm^3 with distilled water.

Apparatus:



7.1 How does the concentration of the acid used in Experiment 2 differ from the concentration of the acid used in Experiment 1? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

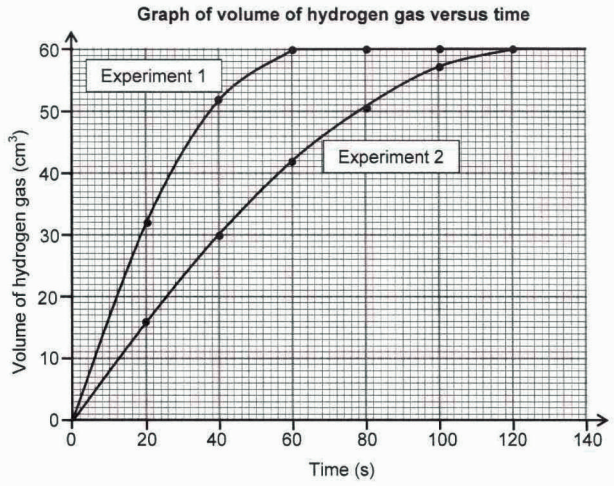
7.2 Write down a hypothesis for this investigation. (2)

7.3 Why should the learners ensure that equal amounts of magnesium powder are used in each of the two experiments? (2)

7.4 The learners use an excess of $HC\ell$ (aq) for the two experiments. Give a reason why the excess $HC\ell$ (aq) will not influence the results. (2)

After completing the investigation, the learners represent the results obtained during each experiment on the graph below.

Graph of volume of hydrogen gas versus time



7.5 Write down the volume of hydrogen gas formed during the first minute in:

7.5.1 Experiment 1 (1)

7.5.2 Experiment 2 (1)

7.6 Which one of the experiments (Experiment 1 or Experiment 2) took place at the faster rate? Refer to the shape of the curves to motivate your answer. (2)

7.7 Give a reason why the final volume of gas produced is the same in both experiments. (1)

7.8 What conclusion can the learners draw from the results obtained? (2)

7.9 How will an increase in the temperature influence the following:

7.9.1 Final volume of gas obtained in each experiment (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)

7.9.2 Volume of gas obtained in each experiment after 40 s (Write down only INCREASES, DECREASES or REMAINS THE SAME.) (1)
[16]

QUESTION 8 (Start on a new page.)

The thermal decomposition of calcium carbonate ($CaCO_3$) is an example of a heterogeneous equilibrium. The decomposition that takes place in a closed container can be represented by the following equation:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

Initially 5 g of $CaCO_3(s)$ is placed in a closed 500 cm^3 container and then heated. Equilibrium is reached at 900 °C.

8.1 Why is the above decomposition referred to as a heterogeneous equilibrium? (1)

8.2 Calculate the mass of unreacted $CaCO_3(s)$ that remains in the container at equilibrium if K_c for the reaction is 0,0108 at 900 °C. (9)

8.3 It is found that the value of K_c increases when the container is heated to a higher temperature. Is the forward reaction exothermic or endothermic? Use Le Chatelier's principle to explain your answer. (3)

8.4 The volume of the container is now decreased to 250 cm^3 while the temperature is kept constant. How will each of the following be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.

8.4.1 The value of K_c (1)

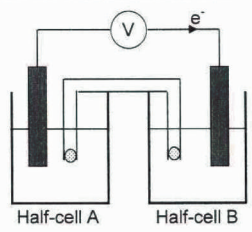
8.4.2 The number of moles of $CaCO_3(s)$ present in the equilibrium mixture (1)

8.4.3 The concentration of $CO_2(g)$ at the new equilibrium (1)

8.5 More $CaCO_3(s)$ is now added to the equilibrium mixture in the 500 cm^3 container. How will this change influence the number of moles of $CO_2(g)$? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[17]

QUESTION 9 (Start on a new page.)

The galvanic cell represented in the diagram below consists of a Mg electrode dipped into a $Mg(NO_3)_2$ solution, and a Pb electrode dipped into a $Pb(NO_3)_2$ solution. Assume that the cell operates under standard conditions.



9.1 State TWO standard conditions under which this cell operates. (2)

9.2 Write down the half-reaction that takes place in half-cell A. (2)

9.3 Write down the cell notation for this cell. (3)

9.4 Calculate the emf of this cell. (4)

9.5 How will each of the following changes influence the value of the cell's emf calculated in QUESTION 9.4? Write down only INCREASES, DECREASES or REMAINS THE SAME.

9.5.1 An increase in $[Mg^{2+}(aq)]$ (1)

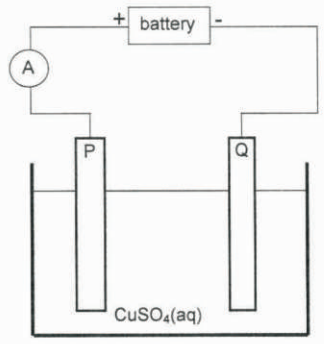
9.5.2 An increase in $[Pb^{2+}(aq)]$ (1)

9.6 In which direction, from half-cell A to B or from half-cell B to A, do cations move within the salt bridge to maintain electrical neutrality? Explain how you arrived at your answer. (4)
[17]

QUESTION 10 (Start on a new page.)

Electrolysis is an important industrial process used to decompose compounds, extract metals from their ores and to purify metals like gold or copper.

The simplified diagram below represents an electrolytic cell used to purify copper.



10.1 Define the term *electrolysis*. (2)

10.2 Which electrode, P or Q, consists of the impure copper? Explain how you arrived at your answer. (3)

10.3 Write down the half-reaction that takes place at electrode Q. (2)

10.4 During purification, metals such as silver and platinum form sludge at the bottom of the container.

Refer to the relative strengths of reducing agents to explain why these two metals do not form ions during the purification process. (2)

10.5 Explain why the concentration of the copper(II) sulphate solution remains constant. Assume that the only impurities in the copper are silver and platinum. (2)

10.6 Why is the sludge of economic importance? (2)
[13]

QUESTION 11 (Start on a new page.)

The chloralkali industry is the second largest consumer of electricity among electrolytic industries. It makes use of brine as electrolyte to produce chlorine gas, hydrogen gas and sodium hydroxide. The overall reaction can be represented by the following equation:

$$2NaC\ell(aq) + 2H_2O(\ell) \rightarrow 2NaOH(aq) + C\ell_2(g) + H_2(g)$$

11.1 Define the term *electrolyte*. (2)

11.2 Give a reason why brine conducts electricity. (1)

11.3 Write down the NAME of the reducing agent in the above reaction. Give a reason for your choice. (2)

11.4 Write down a half-reaction to explain how hydroxide ions are formed during this reaction. (2)

11.5 At which electrode (anode or cathode) is chlorine gas formed? Give a reason for your answer. (2)

11.6 The chloride ions present in the brine solution can contaminate the sodium hydroxide. Briefly describe how this contamination is prevented in the membrane cell. (2)

11.7 Give ONE reason why it is not advisable to build a chloralkali plant close to a residential area. (1)
[12]

QUESTION 12 (Start on a new page.)

Some cells, such as the nickel-cadmium cell used in calculators and electric shavers, can be recharged. Others, such as those used in watches and torches, cannot be recharged.

12.1 Are rechargeable cells primary or secondary cells? (1)

12.2 The half-reactions occurring in a nickel-cadmium cell are shown below:

$Cd(s) + 2OH^-(aq) \rightarrow Cd(OH)_2(s) + 2e^-$ .....(I)

$NiO_2(s) + 2H_2O(\ell) + 2e^- \rightarrow Ni(OH)_2(s) + 2OH^-(aq)$.....(II)

The emf of the nickel-cadmium cell is 1,4 V.

12.2.1 Which ONE of these half-reactions occurs at the cathode? Give a reason for your answer. (2)

12.2.2 Write down the balanced equation for the overall cell reaction. (3)

12.2.3 Calculate the maximum work done by the cell under standard conditions as 1 mol of Cd is used up.
(NOTE: 1 mole of electrons has a charge of $9,65 \times 10^4$ C.) (4)
[10]

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

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

NSC

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↓)

Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

NSC

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)
1 H 2,1																	2 He 4
3 Li 1,0	4 Be 1,5											5 B 2,0	6 C 2,5	7 N 3,0	8 O 3,5	9 F 4,0	10 Ne 20
11 Na 0,9	12 Mg 1,2											13 Aℓ 1,5	14 Si 1,8	15 P 2,1	16 S 2,5	17 Cℓ 3,0	18 Ar 40
19 K 0,8	20 Ca 1,0	21 Sc 1,3	22 Ti 1,5	23 V 1,6	24 Cr 1,6	25 Mn 1,5	26 Fe 1,8	27 Co 1,8	28 Ni 1,8	29 Cu 1,9	30 Zn 1,6	31 Ga 1,6	32 Ge 1,8	33 As 2,0	34 Se 2,4	35 Br 2,8	36 Kr 84
37 Rb 0,8	38 Sr 1,0	39 Y 1,2	40 Zr 1,4	41 Nb 1,6	42 Mo 1,8	43 Tc 1,9	44 Ru 2,2	45 Rh 2,2	46 Pd 2,2	47 Ag 1,9	48 Cd 1,7	49 In 1,7	50 Sn 1,8	51 Sb 1,9	52 Te 2,1	53 I 2,5	54 Xe 131
55 Cs 0,7	56 Ba 0,9	57 La 1,1	72 Hf 1,6	73 Ta 1,5	74 W 1,7	75 Re 1,9	76 Os 2,2	77 Ir 2,2	78 Pt 2,2	79 Au 2,4	80 Hg 1,9	81 Tℓ 1,8	82 Pb 1,8	83 Bi 1,9	84 Po 2,0	85 At 2,2	86 Rn
87 Fr 0,7	88 Ra 0,9	89 Ac 1,1	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	114 Uuq		116 Uuh			

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

29 Cu 63,5 — Symbol *Simbool*; Approximate relative atomic mass *Benaderde relatiewe atoommassa*

Electronegativity *Elektronegatiwiteit*

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

Notes

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Notes