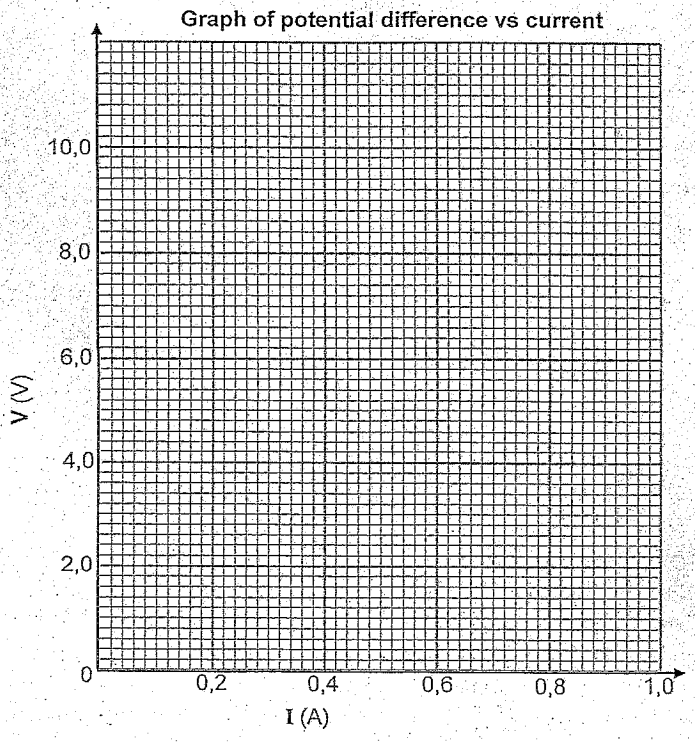
CENTRE NUMBER:

EXAMINATION NUMBER:

QUESTION 8.1.2

ATTACH THIS GRAPH SHEET TO YOUR ANSWER BOOK.



QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following physical quantities is a measure of the inertia of a body?

A Mass

B Energy

C Velocity

D Acceleration (2)

1.2 The magnitude of the gravitational force exerted by one body on another body is *F*. When the distance between the centres of the two bodies is doubled, the magnitude of the gravitational force, in terms of *F*, will now be ...

A $\frac{1}{4}F$

B $\frac{1}{2}F$

C $2F$

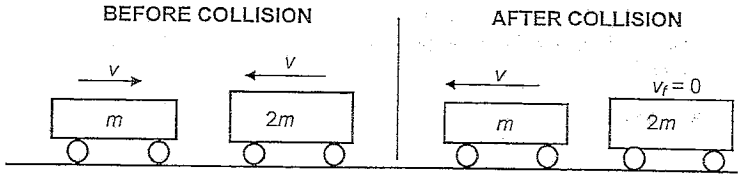
D $4F$ (2)

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

	VELOCITY	ACCELERATION
A	Zero	Zero
B	Zero	Upwards
C	Maximum	Zero
D	Zero	Downwards

(2)

1.4 An object of mass m moving at velocity v collides head-on with an object of mass $2m$ moving in the opposite direction at velocity v. Immediately after the collision the smaller mass moves at velocity v in the opposite direction and the larger mass is brought to rest. Refer to the diagram below.



Ignore the effects of friction.

Which ONE of the following is CORRECT?

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

(2)

1.5 Two balls, P and Q, are dropped simultaneously from the same height. Ball P has TWICE the mass of ball Q. Ignore the effects of air friction.

Just before the balls hit the ground, the kinetic energy of ball P is x. The kinetic energy of ball Q, in terms of x, will be ...

A $\frac{1}{4}x$

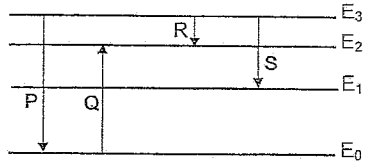
B $\frac{1}{2}x$

C x

D $2x$

(2)

1.6 The diagram below shows the electron transitions P, Q, R and S between different energy levels in an atom.



Which ONE of the transitions will result in an emission of a radiation with the longest wavelength?

A P

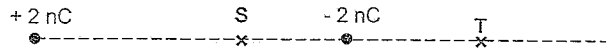
B Q

C R

D S

(2)

1.7 Two charges of + 2 nC and - 2 nC are located on a straight line. S and T are two points that lie on the same straight line as shown in the diagram below.



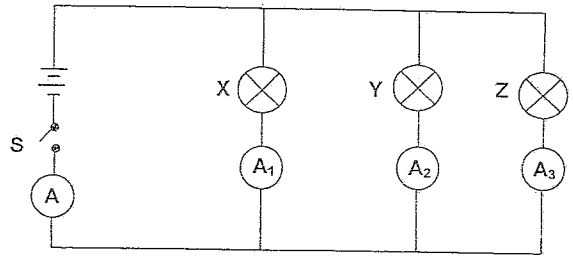
Which ONE of the following correctly represents the directions of the RESULTANT electric fields at S and at T?

	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT S	DIRECTION OF THE RESULTANT ELECTRIC FIELD AT POINT T
A	Right	Left
B	Left	Left
C	Right	Right
D	Left	Right

(2)

1.8 Three light bulbs, **X**, **Y** and **Z** with resistances R, $2R$ and R respectively, are connected in a circuit as shown below. The battery has negligible internal resistance.

When switch **S is closed**, all the bulbs light up. The reading on ammeter **A** is 2,5 A.

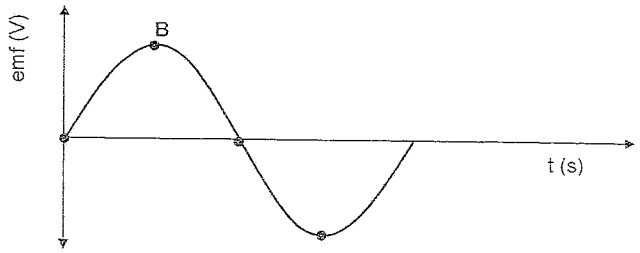


Which ONE of the following correctly describes the readings on the ammeters (in amperes) when bulb **Z** burns out?

	A_1	A_2	A_3	A
A	1,25	1,25	0	2,5
B	1,6	0,8	0,1	2,5
C	0,75	0,75	0	1,5
D	1	0,5	0	1,5

(2)

1.9 The coils of an AC generator make one complete rotation. The resulting graph for the output emf is shown below.



The position **B** on the graph is obtained when the plane of the coil is at an angle of ... to the magnetic field.

A 0°

B 60°

C 90°

D 120°

(2)

1.10 A learner makes the observations below after conducting an experiment using a photocell with frequencies of the incident light being above the threshold frequency (cut-off frequency).

(i) The photocurrent increases as the intensity of the incident light increases.

(ii) The ammeter in the circuit registers a current immediately after the incident light is radiated on the cathode.

(iii) The photocurrent increases as the frequency of the incident light increases.

Which of the observation(s) is/are CORRECT?

A (i) only

B (ii) only

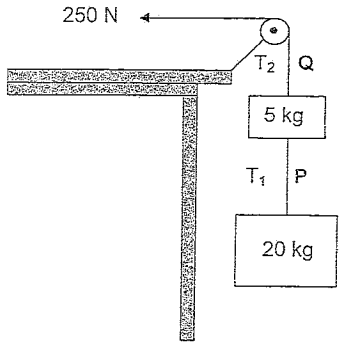
C (i) and (ii) only

D (ii) and (iii) only

(2)
[20]

QUESTION 2 (Start on a new page.)

Two blocks of masses 20 kg and 5 kg respectively are connected by a light inextensible string, P. A second light inextensible string, Q, attached to the 5 kg block, runs over a light frictionless pulley. A constant horizontal force of 250 N pulls the second string as shown in the diagram below. The magnitudes of the tensions in P and Q are T_1 and T_2 respectively. Ignore the effects of air friction.



2.1 State Newton's Second Law of Motion in words. (2)

2.2 Draw a labelled free-body diagram indicating ALL the forces acting on the **5 kg block**. (3)

2.3 Calculate the magnitude of the tension T_1 in string P. (6)

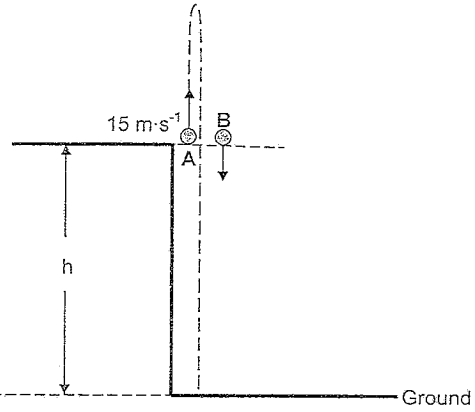
2.4 When the 250 N force is replaced by a sharp pull on the string, one of the two strings break.

Which ONE of the two strings, P or Q, will break? (1)
[12]

QUESTION 3 (Start on a new page.)

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

Both balls undergo free fall and eventually hit the ground.



3.1 Explain the term *free fall*. (2)

3.2 Calculate the time it takes for ball A to return to its starting point. (4)

3.3 Calculate the distance between ball A and ball B when ball A is at its maximum height. (7)

3.4 Sketch a velocity-time graph in the ANSWER BOOK for the motion of ball A from the time it is projected until it hits the ground.

Clearly show the following on your graph:

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

[17]

QUESTION 4 (Start on a new page.)

Dancers have to learn many skills, including how to land correctly. A dancer of mass 50 kg leaps into the air and lands feet first on the ground. She lands on the ground with a velocity of 5 $m \cdot s^{-1}$. As she lands, she bends her knees and comes to a complete stop in 0,2 seconds.

4.1 Calculate the momentum with which the dancer reaches the ground. (3)

4.2 Define the term *impulse* of a force. (2)

4.3 Calculate the magnitude of the net force acting on the dancer as she lands. (3)

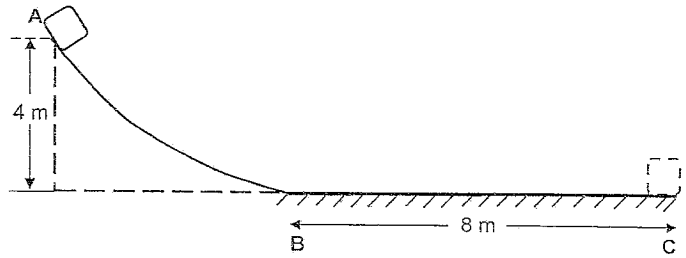
Assume that the dancer performs the same jump as before but lands without bending her knees.

4.4 Will the force now be GREATER THAN, SMALLER THAN or EQUAL TO the force calculated in QUESTION 4.3? (1)

4.5 Give a reason for the answer to QUESTION 4.4. (3)
[12]

QUESTION 5 (Start on a new page.)

5.1 The diagram below shows a track, ABC. The curved section, AB, is frictionless. The rough horizontal section, BC, is 8 m long.



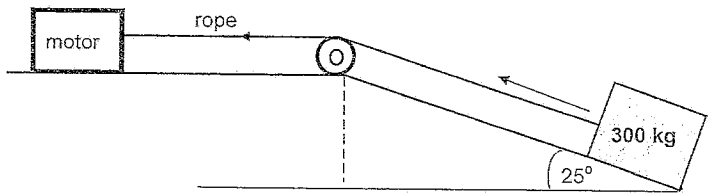
An object of mass 10 kg is released from point A which is 4 m above the ground. It slides down the track and comes to rest at point C.

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

5.1.2 Is mechanical energy conserved as the object slides from A to C? Write only YES or NO. (1)

5.1.3 Using ENERGY PRINCIPLES only, calculate the magnitude of the frictional force exerted on the object as it moves along BC. (6)

5.2 A motor pulls a crate of mass 300 kg with a constant force by means of a light inextensible rope running over a light frictionless pulley as shown below. The coefficient of kinetic friction between the crate and the surface of the inclined plane is 0,19.



5.2.1 Calculate the magnitude of the frictional force acting between the crate and the surface of the inclined plane. (3)

The crate moves up the incline at a constant speed of 0,5 $m \cdot s^{-1}$.

5.2.2 Calculate the average power delivered by the motor while pulling the crate up the incline. (6)
[18]

QUESTION 6 (Start on a new page.)

6.1 The siren of a stationary ambulance emits a note of frequency 1 130 Hz. When the ambulance moves at a constant speed, a stationary observer detects a frequency that is 70 Hz **higher** than that emitted by the siren.

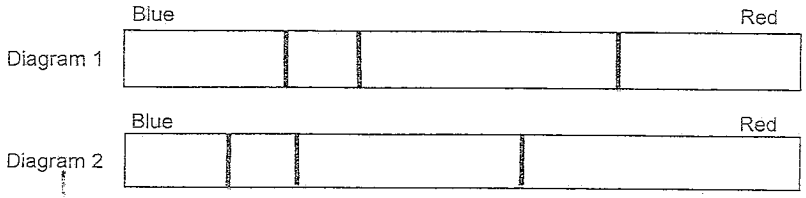
6.1.1 State the Doppler effect in words. (2)

6.1.2 Is the ambulance moving *towards* or *away from* the observer? Give a reason for the answer. (2)

6.1.3 Calculate the speed at which the ambulance is travelling. Take the speed of sound in air as 343 $m \cdot s^{-1}$. (5)

6.2 A study of spectral lines obtained from various stars can provide valuable information about the movement of the stars.

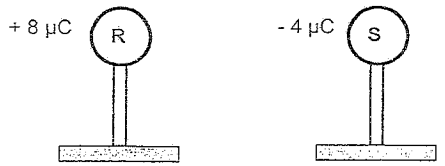
The two diagrams below represent different spectral lines of an element. Diagram **1** represents the spectrum of the element in a laboratory on Earth. Diagram **2** represents the spectrum of the same element from a distant star.



Is the star moving *towards* or *away from* the Earth? Explain the answer by referring to the shifts in the spectral lines in the two diagrams above. (2)
[11]

QUESTION 7 (Start on a new page.)

The diagram below shows two small identical metal spheres, R and S, each placed on a wooden stand. Spheres R and S carry charges of + 8 µC and - 4 µC respectively. Ignore the effects of air.



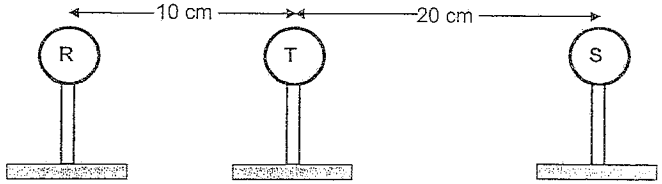
7.1 Explain why the spheres were placed on wooden stands. (1)

Spheres R and S are brought into contact for a while and then separated by a small distance.

7.2 Calculate the net charge on each of the spheres. (2)

7.3 Draw the electric field pattern due to the two spheres R and S. (3)

After R and S have been in contact and separated, a third sphere, T, of charge + 1 µC is now placed between them as shown in the diagram below.



7.4 Draw a free-body diagram showing the electrostatic forces experienced by sphere T due to spheres R and S. (2)

7.5 Calculate the net electrostatic force experienced by T due to R and S. (6)

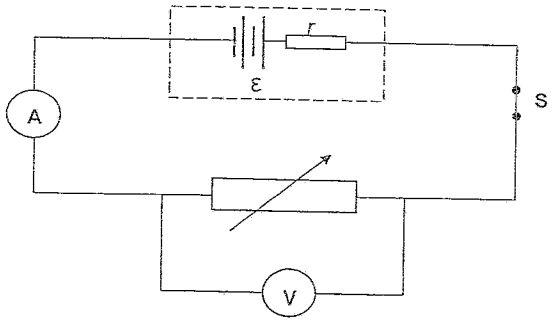
7.6 Define the *electric field at a point.* (2)

7.7 Calculate the magnitude of the net electric field at the location of T due to R and S. (Treat the spheres as if they were point charges.) (3)
[19]

QUESTION 8 (Start on a new page.)

NOTE: The graph for QUESTION 8.1.2 must be drawn on the GRAPH SHEET attached at the end of the QUESTION PAPER.

8.1 A group of learners conduct an experiment to determine the emf (ε) and internal resistance (r) of a battery. They connect a battery to a rheostat (variable resistor), a low-resistance ammeter and a high-resistance voltmeter as shown in the diagram below.



The data obtained from the experiment is displayed in the table below.

READING ON VOLTMETER (V)	READING ON AMMETER (A)
2	0,58
3	0,46
4	0,36
5	0,24
6	0,14

8.1.1 State ONE factor which must be kept constant during the experiment. (1)

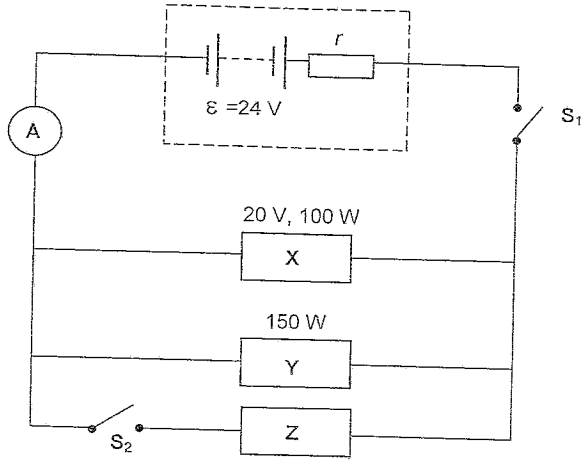
8.1.2 Using the information in the table above, plot the points and draw the line of best fit on the attached GRAPH SHEET. (3)

Use the graph drawn in QUESTION 8.1.2 to determine the following:

8.1.3 Emf (ε) of the battery (1)

8.1.4 Internal resistance of the battery, WITHOUT USING ANY FORM OF THE EQUATION $\varepsilon = I(R + r)$ (3)

8.2 Three electrical devices, X, Y and Z, are connected to a 24 V battery with internal resistance r as shown in the circuit diagram below. The power rating of each of the devices **X** and **Y** are indicated in the diagram.



With switch S_1 closed and S_2 open, the devices function as rated.

Calculate the:

8.2.1 Current in **X** (3)

8.2.2 Resistance of **Y** (3)

8.2.3 Internal resistance of the battery (5)

Now switch S_2 is also closed.

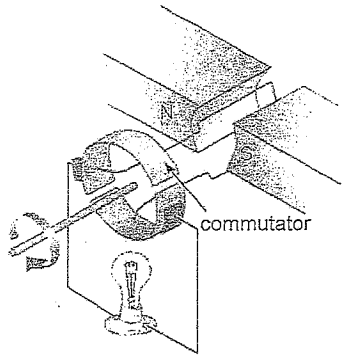
8.2.4 Identify device **Z** which, when placed in the position shown, can still enable **X** and **Y** to operate as rated. Assume that the resistances of all the devices remain unchanged. (1)

8.2.5 Explain how you arrived at the answer to QUESTION 8.2.4. (2)

[22]

QUESTION 9 (Start on a new page.)

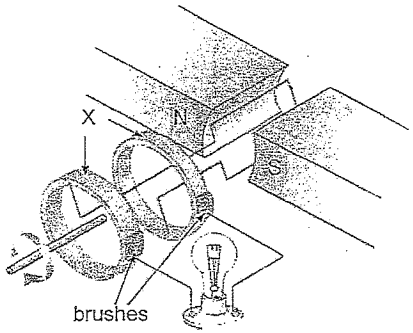
The diagram below represents a simplified version of an electrical machine used to light up a bulb.



9.1 Name the principle on which the machine operates. (1)

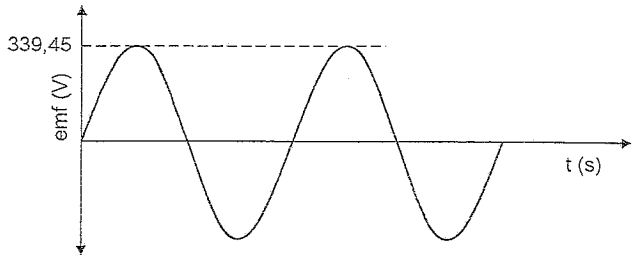
9.2 State ONE way in which to make this bulb burn brighter. (1)

Some changes have been made to the machine and a new device is obtained as shown below.



9.3 Name part **X** in the new device. (1)

9.4 The graph of output emf versus time obtained using the device in QUESTION 9.3 is shown below.

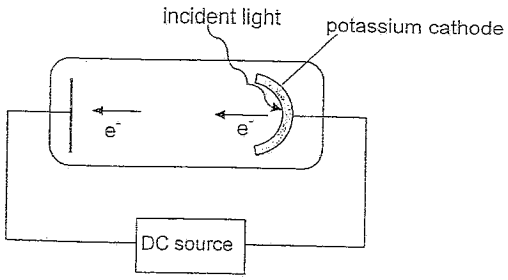


9.4.1 Define the term *root mean square value* of an AC voltage. (2)

9.4.2 Calculate the rms voltage. (3)
[8]

QUESTION 10 (Start on a new page.)

Ultraviolet light is incident onto a photocell with a potassium cathode as shown below. The threshold frequency of potassium is $5,548 \times 10^{14}$ Hz.



10.1 Define the term *threshold frequency (cut-off frequency)*. (2)

The maximum speed of an ejected photoelectron is $5,33 \times 10^5$ m·s^{-1}.

10.2 Calculate the wavelength of the ultraviolet light used. (5)

The photocell is now replaced by another photocell with a rubidium cathode. The maximum speed of the ejected photoelectron is $6,10 \times 10^5$ m·s^{-1} when the same ultraviolet light source is used.

10.3 How does the work function of rubidium compare to that of potassium? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

10.4 Explain the answer to QUESTION 10.3. (3)
[11]

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·s^{-2}
Universal gravitational constant *Universele gravitasiekonstant*	G	6,67 x 10^{-11} N·m^2·kg^{-2}
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 m·s^{-1}
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 N·m^2·C^{-2}
Charge on electron *Lading op elektron*	-e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg
Mass of Earth *Massa van Aarde*	M	5,98 x 10^{24} kg
Radius of Earth *Radius van Aarde*	R_E	6,38 x 10^6 m

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/*BEWEGING*

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

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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

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

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

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$V = \frac{W}{q}$	$E = \frac{F}{q}$
$n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

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

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11. D.

1.1 Which ONE of the following is a primary nutrient for plants?

A Oxygen

B Carbon

C Potassium

D Magnesium (2)

1.2 Which ONE of the following statements is CORRECT?

Alkenes ...

A have the general formula C_nH_{2n+2}.

B are unsaturated hydrocarbons.

C readily undergo substitution reactions.

D have one triple bond between two carbon atoms. (2)

1.3 Consider the reaction represented by the balanced equation below:

$$Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$$

In the above reaction, Cu(s) is the ...

A oxidising agent and is reduced.

B oxidising agent and is oxidised.

C reducing agent and is reduced.

D reducing agent and is oxidised. (2)

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARDREDUKSIEPOTENSIALE

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
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	−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

1.4 Which ONE of the following describes the effect of a positive catalyst on the net activation energy and the heat of reaction (ΔH) of a specific reaction?

	NET ACTIVATION ENERGY	ΔH
A	Increases	No effect
B	Decreases	Increases
C	No effect	Decreases
D	Decreases	No effect

(2)

1.5 The following equation represents the cracking of a hydrocarbon at high temperature and pressure:

$$C_{11}H_{24} \rightarrow 2C_2H_4 + Y + C_4H_{10}$$

Which ONE of the following is the IUPAC name of product Y?

A Prop-1-ene

B Propane

C Ethene

D Ethane (2)

1.6 When 2-chlorobutane is strongly heated in the presence of concentrated sodium hydroxide, the major product formed is ...

A but-1-ene.

B but-2-ene.

C butan-1-ol.

D butan-2-ol. (2)

1.7 A hypothetical reaction reaches equilibrium at 10 °C in a closed container according to the following balanced equation:

$$A(g) + B(g) \rightleftharpoons AB(g) \qquad \Delta H < 0$$

The temperature is now increased to 25 °C. Which ONE of the following is correct as the reaction approaches a new equilibrium?

	REACTION RATE	YIELD OF PRODUCTS
A	Increases	Remains the same
B	Increases	Decreases
C	Increases	Increases
D	Decreases	Decreases

(2)

1.8 Which ONE of the following represents the products formed during the hydrolysis of ammonium chloride?

A $NH_3(aq)$ and $H_3O^+(aq)$

B $NH_4^+(aq)$ and $Cl^-(aq)$

C $HCl(aq)$ and $OH^-(aq)$

D $Cl^-(aq)$ and $H_3O^+(aq)$ (2)

1.9 An electrochemical cell is used to electroplate an iron spoon with nickel.

Which ONE of the following half-reactions takes place at the positive electrode of this cell?

A $Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$

B $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$

C $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$

D $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$ (2)

1.10 The following reaction reaches equilibrium in a closed container at a certain temperature:

$$2O_3(g) \rightleftharpoons 3O_2(g)$$

The pressure is now decreased by increasing the volume of the container at constant temperature.

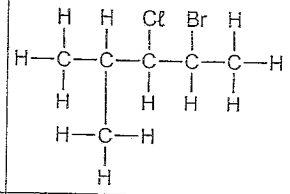
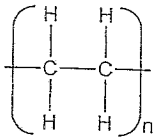
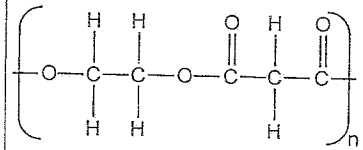
Which ONE of the following is correct as the reaction approaches a new equilibrium?

	NUMBER OF MOLES OF $O_3(g)$	NUMBER OF MOLES OF $O_2(g)$	CONCENTRATION OF $O_2(g)$
A	Increases	Decreases	Decreases
B	Decreases	Increases	Increases
C	Decreases	Increases	Decreases
D	Increases	Decreases	Increases

(2)
[20]

QUESTION 2 (Start on a new page.)

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

A	2,2,4-trimethylhexane	B	$CH_3CH_2CH_2CH_2CHO$
C		D	
E		F	Pentan-2-one

2.1 Write down the LETTER that represents the following:

2.1.1 An aldehyde (1)

2.1.2 A condensation polymer (1)

2.1.3 A compound which has a carbonyl group bonded to two carbon atoms as its functional group (1)

2.2 Write down the IUPAC name of:

2.2.1 Compound **C** (3)

2.2.2 The monomer of compound **D** (1)

2.3 Write down the structural formula of:

2.3.1 Compound **A** (2)

2.3.2 Compound **F** (2)

2.4 The table contains compounds which are functional isomers.

2.4.1 Define the term *functional isomer.* (2)

2.4.2 Write down the LETTERS that represent two compounds that are functional isomers. (1)
[14]

QUESTION 3 (Start on a new page.)

3.1 Give a reason why alkanes are *saturated* hydrocarbons. (1)

3.2 Write down the structural formula of:

3.2.1 The functional group of alcohols (1)

3.2.2 A tertiary alcohol that is a structural isomer of butan-1-ol (2)

3.3 Learners investigate factors that influence the boiling points of alkanes and alcohols. In one of the investigations they determine the boiling points of the first three alkanes.

3.3.1 Write down an investigative question for this investigation. (2)

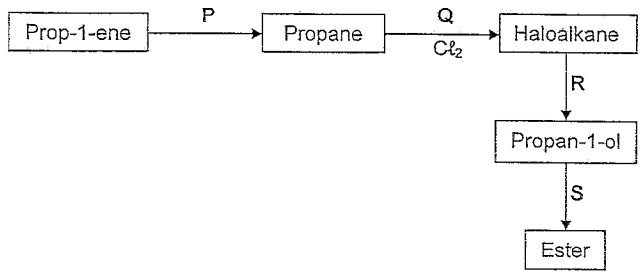
3.3.2 Fully explain why the boiling point increases from methane to propane. (3)

3.4 The learners find that the boiling point of propan-1-ol is higher than that of propane.

Explain this observation by referring to the TYPE of INTERMOLECULAR FORCES present in each of these compounds. (3)
[12]

QUESTION 4 (Start on a new page.)

The flow diagram below shows the preparation of an ester using prop-1-ene as a starting reagent. **P**, **Q**, **R** and **S** represent different organic reactions.



4.1 Write down the type of reaction represented by:

4.1.1 **Q** (1)

4.1.2 **R** (1)

4.2 For reaction **P** write down the:

4.2.1 Type of addition reaction (1)

4.2.2 Balanced equation using structural formulae (3)

4.3 Write down the structural formula of the haloalkane formed in reaction **Q**. (2)

4.4 In reaction **S** propan-1-ol reacts with ethanoic acid to form the ester.

For this reaction write down the:

4.4.1 Name of the reaction that takes place (1)

4.4.2 FORMULA or NAME of the catalyst needed (1)

4.4.3 Structural formula of the ester formed (2)

4.4.4 IUPAC name of the ester formed (2)

4.5 The propan-1-ol formed in reaction **R** can be converted to prop-1-ene. Write down the FORMULA or NAME of the inorganic reagent needed. (1)
[15]

QUESTION 5 (Start on a new page.)

5.1 Define the term *reaction rate* in words. (2)

Learners use the reaction between IMPURE POWDERED calcium carbonate and excess hydrochloric acid to investigate reaction rate. The balanced equation for the reaction is:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

They perform four experiments under different conditions of concentration, mass and temperature as shown in the table below. They use identical apparatus in the four experiments and measure the volume of gas released in each experiment.

	EXPERIMENT			
	1	2	3	4
Concentration of acid ($mol \cdot dm^{-3}$)	1	0,5	1	1
Mass of impure calcium carbonate (g)	15	15	15	25
Initial temperature of acid (°C)	30	30	40	40

5.2 The results of experiments **1** and **3** are compared in the investigation.

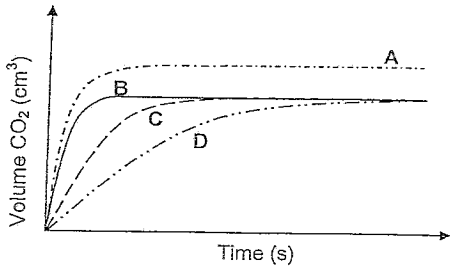
Write down the:

5.2.1 Independent variable (1)

5.2.2 Dependent variable (1)

5.3 Use the collision theory to explain why the reaction rate in experiment **4** will be higher than that in experiment **3**. (3)

The learners obtain graphs **A**, **B**, **C** and **D** below from their results.



5.4 Which ONE of the graphs (**A**, **B**, **C** or **D**) represents experiment **1**? Fully explain the answer by comparing experiment **1** with experiments **2**, **3** and **4**. (6)

5.5 When the reaction in experiment **4** reaches completion, the volume of gas formed is 4,5 dm^3. Assume that the molar gas volume at 40 °C is equal to 25,7 dm^3.

Calculate the mass of the impurities present in the calcium carbonate. (5)
[18]

QUESTION 6 (Start on a new page.)

A certain amount of nitrogen dioxide gas (NO_2) is sealed in a gas syringe at 25 °C. When equilibrium is reached, the volume occupied by the reaction mixture in the gas syringe is 80 cm^3. The balanced chemical equation for the reaction taking place is:

$$\underset{\text{dark brown}}{2NO_2(g)} \rightleftharpoons \underset{\text{colourless}}{N_2O_4(g)} \qquad \Delta H < 0$$

6.1 Define the term *chemical equilibrium*. (2)

6.2 At equilibrium the concentration of the $NO_2(g)$ is 0,2 $mol \cdot dm^{-3}$. The equilibrium constant for the reaction is 171 at 25 °C.

Calculate the initial number of moles of $NO_2(g)$ placed in the gas syringe. (8)

6.3 The diagram below shows the reaction mixture in the gas syringe after equilibrium is established.

The pressure is now increased by decreasing the volume of the gas syringe at constant temperature as illustrated in the diagram below.

6.3.1 IMMEDIATELY after increasing the pressure, the colour of the reaction mixture in the gas syringe appears darker than before. Give a reason for this observation. (1)

After a while a new equilibrium is established as illustrated below. The colour of the reaction mixture in the gas syringe now appears lighter than the initial colour.

6.3.2 Use Le Chatelier's principle to explain the colour change observed in the gas syringe. (3)

6.4 The temperature of the reaction mixture in the gas syringe is now increased and a new equilibrium is established. How will each of the following be affected?

6.4.1 Colour of the reaction mixture
Write down only DARKER, LIGHTER or REMAINS THE SAME. (1)

6.4.2 Value of the equilibrium constant (K_c)
Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[16]

QUESTION 7 (Start on a new page.)

7.1 Nitric acid (HNO_3), an important acid used in industry, is a strong acid.

7.1.1 Give a reason why nitric acid is classified as a strong acid. (1)

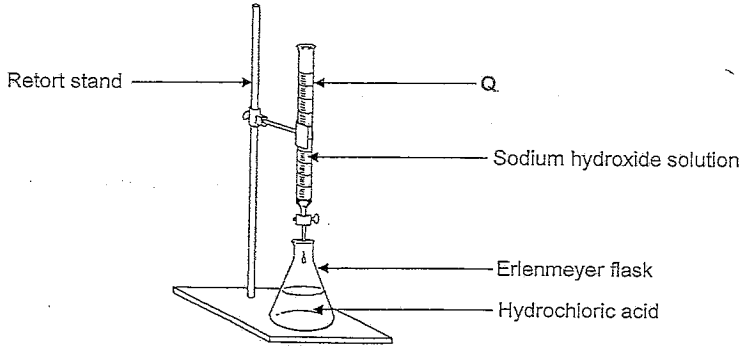
7.1.2 Write down the NAME or FORMULA of the conjugate base of nitric acid. (1)

7.1.3 Calculate the pH of a 0,3 mol·dm^{-3} nitric acid solution. (3)

7.2 A laboratory technician wants to determine the percentage purity of magnesium oxide. He dissolves a 4,5 g sample of the magnesium oxide in 100 cm^3 hydrochloric acid of concentration 2 mol·dm^{-3}.

7.2.1 Calculate the number of moles of hydrochloric acid added to the magnesium oxide. (3)

He then uses the apparatus below to titrate the EXCESS hydrochloric acid in the above solution against a sodium hydroxide solution.



7.2.2 Write down the name of apparatus **Q** in the above diagram. (1)

7.2.3 The following indicators are available for the titration:

INDICATOR	pH RANGE
A	3,1 – 4,4
B	6,0 – 7,6
C	8,3 – 10,0

Which ONE of the above indicators (**A**, **B** or **C**) is most suitable to indicate the exact endpoint in this titration? Give a reason for the answer. (3)

7.2.4 During the titration, the technician uses distilled water to wash any sodium hydroxide spilled against the sides of the Erlenmeyer flask into the solution.

Give a reason why the addition of distilled water to the Erlenmeyer flask will not influence the results. (1)

7.2.5 At the endpoint of the titration he finds that 21 cm^3 of a 0,2 mol dm^{-3} sodium hydroxide solution has neutralised the EXCESS hydrochloric acid.

Calculate the number of moles of hydrochloric acid in excess. (3)

7.2.6 The balanced equation for the reaction between hydrochloric acid and magnesium oxide is:

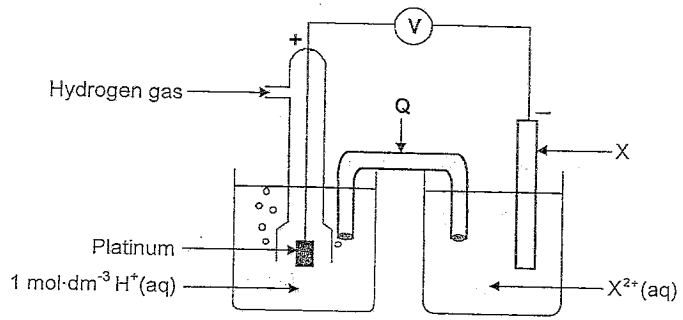
$$MgO(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + 2H_2O(\ell)$$

Calculate the percentage purity of the magnesium oxide. Assume that only the magnesium oxide in the 4,5 g sample reacted with the acid. (5)

[21]

QUESTION 8 (Start on a new page.)

A standard electrochemical cell is set up using a standard hydrogen half-cell and a standard $X|X^{2+}$ half-cell as shown below. A voltmeter connected across the cell, initially registers 0,31 V.



8.1 Besides concentration write down TWO conditions needed for the hydrogen half-cell to function under standard conditions. (2)

8.2 Give TWO reasons, besides being a solid, why platinum is suitable to be used as electrode in the above cell. (2)

8.3 Write down the:

8.3.1 NAME of component **Q** (1)

8.3.2 Standard reduction potential of the $X|X^{2+}$ half-cell (1)

8.3.3 Half-reaction that takes place at the cathode of this cell (2)

8.4 The hydrogen half-cell is now replaced by a $M|M^{2+}$ half-cell. The cell notation of this cell is:

$$M(s) \mid M^{2+}(aq) \parallel X^{2+}(aq) \mid X(s)$$

The initial reading on the voltmeter is now 2,05 V.

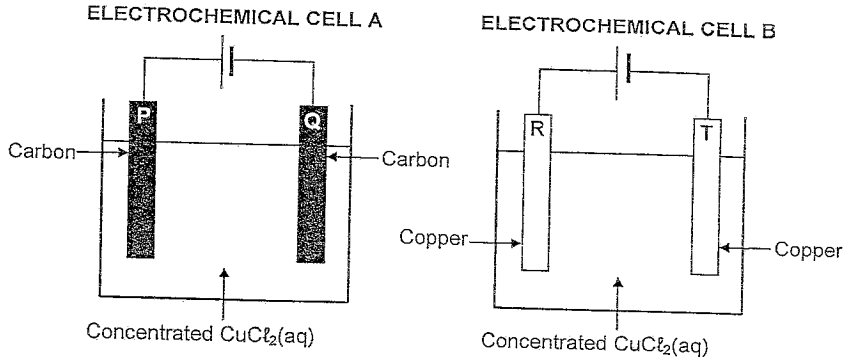
8.4.1 Identify metal **M**. Show how you arrived at the answer. (5)

8.4.2 Is the cell reaction EXOTHERMIC or ENDOTHERMIC? (1)

8.5 The reading on the voltmeter becomes zero after using this cell for several hours. Give a reason for this reading by referring to the cell reaction. (1)
[15]

QUESTION 9 (Start on a new page.)

The simplified diagrams below represent two electrochemical cells, A and B. A concentrated copper(II) chloride solution is used as electrolyte in both cells.



9.1 Are **A** and **B** ELECTROLYTIC or GALVANIC cells? (1)

9.2 Which of the electrodes (**P**, **Q**, **R** or **T**) will show a mass increase? Write down a half-reaction to motivate the answer. (4)

9.3 Write down the NAME or FORMULA of the product formed at:

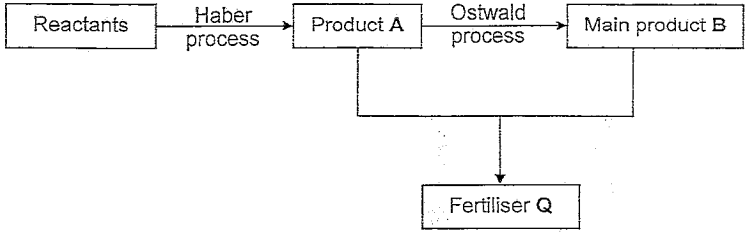
9.3.1 Electrode **P** (1)

9.3.2 Electrode **R** (1)

9.4 Fully explain the answer to QUESTION 9.3.2 by referring to the relative strengths of the reducing agents involved. (3)
[10]

QUESTION 10 (Start on a new page.)

10.1 The flow diagram below shows the processes involved in the industrial preparation of fertiliser **Q**.

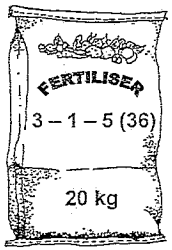


Write down the:

10.1.1 NAMES or FORMULAE of the reactants used in the Haber process (2)

10.1.2 Balanced equation for the formation of fertiliser **Q** (3)

10.2 The diagram below shows a bag of NPK fertiliser.



Calculate the mass of nitrogen in the bag. (4)
[9]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$c=\frac{n}{V}$ or/*of* $c=\frac{m}{MV}$	$n=\frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b}=\frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

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

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
																	2 He 4
1 2,1 H 1												5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
3 1,0 Li 7	4 1,5 Be 9											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
11 0,9 Na 23	12 1,2 Mg 24																
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 1,8 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,9 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 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 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*

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

Approximate relative atomic mass *Benaderde relatiewe atoommassa*

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARDREDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* →

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
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 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
$Al^{3+} + 3e^- \rightleftharpoons Al$	− 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	− 2,36
$Na^+ + e^- \rightleftharpoons Na$	− 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	− 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	− 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	− 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	− 2,92
$K^+ + e^- \rightleftharpoons K$	− 2,93
$Li^+ + e^- \rightleftharpoons Li$	− 3,05

← Increasing reducing ability/*Toenemende reduserende vermoë*