Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2020

PHYSICAL SCIENCES P2 (CHEMISTRY) EXEMPLAR

MARKS: **150**

TIME: **3 hours**

IPHSCE2

This question paper consists of 18 pages, including 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

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

5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

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

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

11. You are advised to use the attached DATA SHEETS.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A−D), next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The distance between the nuclei of two adjacent atoms when atoms bond is called …

A bond length.

B bond energy.

C interatomic bond.

D intermolecular forces. (2)

1.2 Which ONE of the following substances has ION-DIPOLE forces?

A H_2O (ℓ)

B CO_2 (g)

C NaCℓ (aq)

D NaCℓ (s) (2)

1.3 The geometrical shape of the $PCℓ_5$ molecule according to VSEPR theory is …

A linear.

B trigonal planar.

C tetrahedral.

D trigonal bipyramidal. (2)

1.4 ONE mole of water (H_2O) and ONE mole of carbon dioxide (CO_2) will have the same…

A mass.

B molar mass.

C number of molecules.

D density. (2)

1.5 A certain mass of oxygen is sealed in a syringe. The gas exerts a pressure **p**. If both the volume and the temperature are doubled, the new pressure of the gas will be …

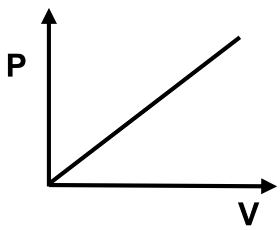
A **p**

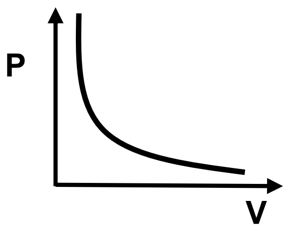
B $\frac{1}{2}$ **p**

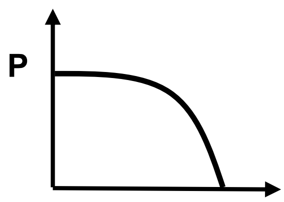
C 2 **p**

D 4 **p** (2)

1.6 The relationship between pressure and volume of a fixed amount of gas at constant temperature is BEST described by …

A


B


C


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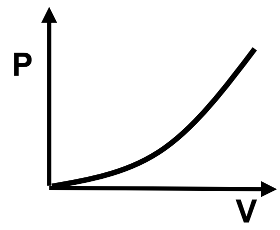


(2)

1.7 Equal masses of each of the following gases He, O_2, CH_4 and N_2 are placed in separate containers at the same temperature and pressure.

Which ONE of the gases will have the LARGEST volume?

A He

B O_2

C CH_4

D N_2 (2)

1.8 Consider the reaction:

$$NH_3\,(aq) + \mathbf{X} \rightarrow NH_4^+\,(aq) + OH^-(aq)$$

X represents …

A H_2O acting as an acid.

B H_2O acting as a base.

C H_3O^+ acting as an acid.

D H_3O^+ acting as a base. (2)

1.9 Consider the pairs of reactants given below.

Which ONE of the following pairs of reactants will produce a salt, water and carbon dioxide?

A $Zn + H_2SO_4$

B $NaOH + HC\ell$

C $CuO + H_2SO_4$

D $Na_2CO_3 + HC\ell$ (2)

1.10 Consider the following redox reaction:

$$Cr_2O_7^{2-}(aq) + Fe^{2+}(aq) + H^+(aq) \rightarrow Cr^{3+}(aq) + Fe^{3+}(aq) + H_2O(\ell)$$

The product of the reduction half reaction in the equation is …

A Fe^{3+}

B Cr^{3+}

C H_2O

D H^+ (2)

[20]

QUESTION 2 (Start on a NEW page.)

Consider the following chemical equations:

I: $CH_4 + 2\,O_2 \rightarrow CO_2 + 2\,H_2O$

II : $NH_3 + H^+ \rightarrow NH_4^+$

2.1 Define the term *covalent bond*. (2)

2.2 Write down the Lewis structure for the CH_4 molecule. (2)

2.3 Consider the bonds C – H and O – H

Which bond …

2.3.1 has a longer bond length? Give a reason for your answer. (2)

2.3.2 is stronger? (1)

2.4 How many lone pairs of electrons are in the central atom of the H_2O molecule? (1)

2.5 Write down the formula of a substance in reaction **II** that has a dative covalent bond. (1)

2.6 The NH_3 molecule is POLAR but the CH_4 molecule is NON-POLAR.

Explain this observation. (4)

[13]

QUESTION 3 (Start on a NEW page.)

3.1 The boiling points in the table below were obtained during an investigation carried out to compare the boiling points of group 7 hydrides. The hydrides, HCℓ and HBr, are labelled in the table as compounds **A** and **B** respectively.

Compound		**Molecular mass ($g.mol^{-1}$)**	**Boiling point (° C)**
A	HCℓ	36,6	- 85
B	HBr	81	- 66

3.1.1 Define the term *boiling point.* (2)

3.1.2 In what phase are compounds (**A** and **B**) at 0 °C and 101 kPa of external pressure? (1)

3.1.3 Name the type of intermolecular force that exists between molecules of both compounds **A** and **B** due to the polar nature of these molecules. (1)

3.1.4 Which ONE of the compounds (**A** or **B**), has STRONGER London forces (dispersion forces)?

Give a reason for your answer. (3)

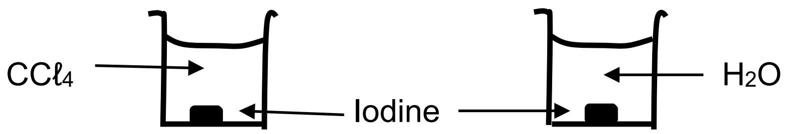
3.1.5 Which compound (**A** or **B**), will have the higher vapour pressure?

Give a reason for the answer by referring to the data in the table. (2)

Compound **C** (HF), not shown in the table, has a smaller molecular size than both compounds **A** and **B** but has a relatively higher boiling point of 19,5 °C.

3.1.6 Explain why the boiling point of compound **C** is HIGHER than that of compounds **A** and **B** by referring to the TYPE and STRENGTH of intermolecular forces involved. (3)

3.2 Solid iodine (I_2) is added to equal volumes of carbon tetrachloride ($CCℓ_4$) and water in separate test tubes as shown in the diagram below.



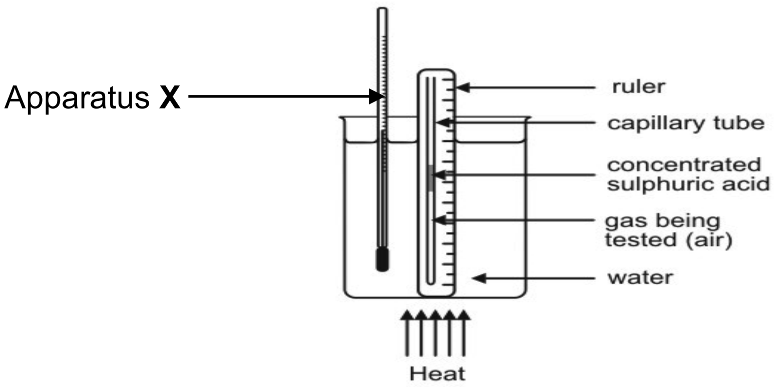
3.2.1 In which liquid ($CCℓ_4$ or H_2O), will the iodine dissolve? (1)

3.2.2 Explain the answer to QUESTION 3.2.1 above by referring to the intermolecular forces involved.

(3)
[16]

QUESTION 4 (Start on a NEW page.)

Grade 11 learners want to verify the relationship between temperature and volume of a gas. They used the following experimental set-up.



4.1 Write down the name of the gas law that is investigated. (1)

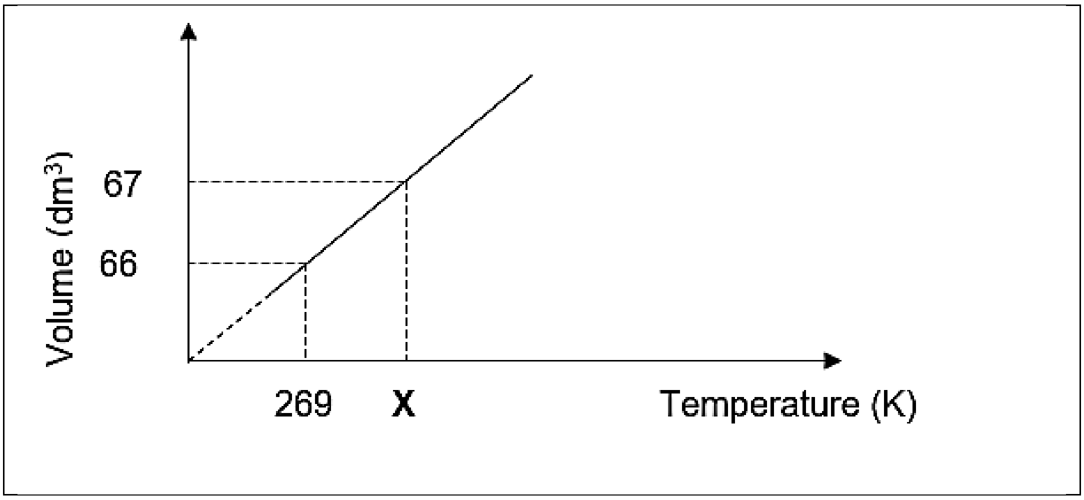
4.2 For this investigation write down the:

4.2.1 Investigative question (2)

4.2.2 Controlled variable (1)

4.3 Write down the name of apparatus **X**. (1)

4.4 The learners plot the results of their investigation on the graph below:



4.4.1 Determine, by calculation, the value of **X**.

132 g of CO_2 gas was used in the above investigation. (4)

4.4.2 Calculate the pressure of the gas at 269 K. (5)

4.5 Write down the TWO conditions of temperature and pressure at which real gases deviate from the ideal gas behaviour. (2)

4.6 The CO_2 used in the investigation is replaced with an equal amount of H_2 (g).

Which gas (CO_2 or H_2) behaves more closely to an ideal gas?

Give TWO reasons for your answer. (3)

[19]

QUESTION 5 (Start on a NEW page.)

Learners study ENDOTHERMIC and EXOTHERMIC reactions by conducting experiments **I** and **II** in which the reactions shown in the table below take place.

EXPERIMENT	BALANCED EQUATION
I	$2\ H_2O_2\,(\ell) \rightarrow 2\ H_2O\,(\ell) + O_2(g)$
II	$2\ H_2O\,(\ell) \rightarrow 2\ H_2\,(g) + O_2\,(g)$

The learners measured the initial and final temperatures of the reaction mixtures. They also obtained activation energies for the reactions from a data table.

The learners represented their findings in a table as shown below.

EXPERIMENT	Initial (˚C)	Final (˚C)	Activation energy (kJ/mol)
I	24	36	75
II	24	18	237

5.1 Define the term *activation energy.* (2)

5.2 In which experiment (**I** or **II**) is the reaction EXOTHERMIC?

Explain your answer. (2)

5.3 Is the heat of the reaction, ΔH, POSITIVE or NEGATIVE for an EXOTHERMIC reaction? (1)

5.4 Write down the general name of a substance that can be added to the reaction mixture in experiment **II** to reduce the activation energy. (1)

5.5 Both reactions produce the same number of moles of oxygen gas.

How does the mass of H_2O_2 used in experiment **I** compare to the mass of H_2O used in experiment **II**?

Write down only SMALLER THAN, LARGER THAN or THE SAME. (2)

5.6 Draw a potential energy versus time graph for the reaction in experiment **II**.

The following must be shown on the graph.

- Heat of the reaction (ΔH)
- Activation energy (E_a) (3)

[11]

QUESTION 6 (Start on a NEW page.)

6.1 Methyl propanoate is an organic compound with the following percentage composition:

54,55% C ; 9,09% H ; 36,36% O

The molar mass of the compound is 88 g·mol^{-1}.

6.1.1 Define the term *empirical formula*. (2)

6.1.2 Determine, by calculation, the empirical formula. (6)

6.1.3 Determine the molecular formula. (2)

6.2 Learners prepare a solution of sodium hydroxide (NaOH) in water by placing 8 g of sodium hydroxide (NaOH) in a volumetric flask and adding water to produce 250 cm^3 of solution after stirring.

6.2.1 Define *concentration* in words. (2)

6.2.2 Calculate the concentration of the sodium hydroxide (NaOH) solution. (4)

6.3 Sodium azide (NaN_3) is used in car airbags. For the airbag to inflate the following reaction must take place:

$$2\ NaN_3\ (s) \rightarrow 2\ Na\ (s) + 3\ N_2\ (g)$$

Calculate the volume of nitrogen gas (N_2) that would be produced at STP if 55 g of sodium azide reacts completely. (5)

[21]

QUESTION 7 (Start on a NEW page.)

The fertiliser ammonium sulphate ($(NH_4)_2SO_4$) is produced from the reaction of sulphuric acid (H_2SO_4) and ammonia (NH_3) according to the balanced equation:

$$H_2SO_4 + 2\,NH_3 \longrightarrow (NH_4)_2SO_4$$

2 kg of sulphuric acid and 58,82 moles of ammonia are available to produce the fertiliser.

7.1 Define the term *limiting reagent.* (2)

7.2 Calculate the maximum mass of ammonium sulphate that can be produced by the reaction. (7)

[9]

QUESTION 8 (Start on a NEW page.)

8.1 Consider the chemical reaction below:

$$HPO_4^{2-}(aq) + H_2O(\ell) \rightarrow PO_4^{3-}(aq) + H_3O^+(aq)$$

8.1.1 Define a *base* according to a Lowry-Bronsted theory. (2)

8.1.2 Write down ONE conjugate acid-base pair in the equation. (1)

8.1.3 Is the reaction mixture ACIDIC or ALKALINE at the completion of the reaction? Give a reason for your answer. (2)

8.1.4 Write down the formula of a substance in the reaction, other than H_2O, that can act as an ampholyte in some reactions. (2)

8.2 Copper (II) oxide (CuO) reacts with nitric acid.

Write down a balanced equation for the reaction. (3)

8.3 40 g of IMPURE calcium carbonate reacts with a 200 cm^3 of a dilute sulphuric acid with a concentration of 1,5 $mol{\cdot}dm^{-3}$. All the calcium carbonate and sulphuric acid react completely leaving the impurities unreacted at the completion of the reaction.

$$CaCO_3(s) + H_2SO_4(aq) \rightarrow CaSO_4(s) + CO_2(g) + H_2O(\ell)$$

8.3.1 Calculate the percentage purity of the calcium carbonate. (6)

To obtain the sulphuric acid solution of concentration 1,5 $mol.dm^{-3}$ that reacted with the IMPURE calcium carbonate, 10 cm^3 of a concentrated sulphuric acid solution of concentration 9 $mol{\cdot}dm^{-3}$ was added to water.

8.3.2 Calculate the volume of water required to dilute the concentrated sulphuric acid solution to a concentration of 1,5 $mol{\cdot}dm^{-3}$. (4)

[20]

QUESTION 9 (Start on a NEW page.)

9.1 Consider the redox reaction given below.

$$Fe^{3+} + Zn \rightarrow Zn^{2+} + Fe^{2+}$$

9.1.1 Define *oxidation reaction* in terms of electron transfer. (2)

Write down the:

9.1.2 Formula of the reducing agent (2)

9.1.3 Reduction half reaction (2)

9.2 Consider the redox reaction below:

$$Ag\ (s) + NO_3^- (aq) \rightarrow NO_2\ (g) + Ag^+ (aq)$$

9.2.1 Determine the oxidation number of nitrogen (N) in NO_3^-. (2)

9.2.2 Balance the above chemical equation using the ion-electron method. (4)
[12]

QUESTION 10 (Start on a NEW page.)

10.1 The mining industry contributes towards the South African economy. Gold is one of the minerals that is being mined in South Africa.

10.1.1 Write down the name of the location of the major mining activity in South Africa. (1)

The following chemical reaction occurs during the final steps in the recovery process of gold.

$$Zn + 2\ NaAu(CN)_2 \rightarrow 2\ Au + Zn(CN)_2 + 2\ NaCN$$

10.1.2 Is gold OXIDISED or REDUCED during the reaction?

Explain the answer by referring to the oxidation number. (3)

10.1.3 The NaCN is one of the products formed in the reaction.

Give a reason why chemists MUST ensure that NaCN does not find its way to nearby water sources. (2)

10.1.4 Write down the name of the process that is followed after this reaction. (1)

10.2 The burning of fossil fuels has a negative impact on the environment.

Write down TWO negative impacts of the large-scale burning of fossil fuels. (2)
[9]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 2 (CHEMIE)

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

NAAM/*NAME*	SIMBOOL/*SYMBOL*	WAARDE/*VALUE*
Standard pressure *Standaarddruk*	p^{θ}	$1,013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume teen 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 se konstante*	N_A	$6,02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$ or/of $n = \frac{N}{N_A}$ or/of $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$ $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1x10^{-14}$ at /by 298K
$E^{\theta}_{cell} = E^{\theta}_{cathode} – E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} – E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} – E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} – E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} – E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} – E^{\theta}_{reduseermiddel}$		

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

KEY/ *SLEUTEL*

Elektronegatiwiteit / Electronegativity	*Atoomgetal* / Atomic number	*Simbool* / Symbol	*Benaderde relatiewe atoommassa* / Approximate relative atomic mass
1,9	29	Cu	63,5

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 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											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
11 0,9 Na 23	12 1,2 Mg 24											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
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 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 1,6 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

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* (↓)

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

Increasing oxidising ability/*Toenemende oksiderende 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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

Province of the
EASTERN CAPE
EDUCATION

NATIONAL
SENIOR CERTIFICATE/
NASIONALE
SENIOR SERTIFIKAAT

GRADE/*GRAAD* 11

NOVEMBER 2020

PHYSICAL SCIENCES P2/
FISIESE WETENSKAPPE V2
MARKING GUIDELINE/*NASIENRIGLYN*
(EXEMPLAR/*EKSEMPLAAR)*

MARKS/*PUNTE*: 150

This marking guideline consists of 12 pages./
Hierdie nasienriglyn bestaan uit 12 bladsye.

QUESTION 1/*VRAAG 1*

1.1 A √√ (2)
1.2 C √√ (2)
1.3 D √√ (2)
1.4 C √√ (2)
1.5 A √√ (2)
1.6 B √√ (2)
1.7 A √√ (2)
1.8 A √√ (2)
1.9 D √√ (2)
1.10 B √√ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1 The <u>sharing of electrons</u> between two atoms to form a molecule. ✓✓ /
Die <u>deel van elektrone</u> tussen twee atome om 'n molekuul te vorm. (2)

2.2

```
    H
    ..
H : C : H ✓✓
    ..
    H
```
(2)

2.3 2.3.1 C – H. ✓ O-atom has a smaller atomic radius than the C-atom. ✓
O-atoom het 'n 2 kleiner atomiese radius as die C-atoom.

OR/ *OF*

C-atom has a larger atomic radius than the O-atom.
C-atoom het 'n groter atomiese radius as die O-atoom. (2)

2.3.2 O - H ✓ (1)

2.4 Two / Twee ✓ **OR/*OF*** 2 (1)

2.5 NH_4^+ ✓ (1)

2.6 N-atom is more electronegative than the H-atom. ✓
The NH_3 molecular geometry/charge distribution is asymmetrical ✓ / The electron density (charges) will be distributed unevenly around the molecule.

N-atoom is meer elektron-negatief as die H-atoom
Die NH_3 se molekulêre geometrie/lading is asimmetries versprei /
Die elektrondigtheid (lading) sal oneweredig rondom die molekuul versprei wees.

C-atom is more electronegative than the H-atom ✓ but CH_4 molecular geometry / charge distribution is symmetrical ✓

C-atoom is meer elektron-negatief as die H-atoom maar die CH_4 molekulêre geometrie/lading verspreiding is simmetries. (4)

[13]

QUESTION 3/*VRAAG 3*

3.1 3.1.1 The temperature at which the vapour pressure of a liquid equals atmospheric pressure. ✓✓
Die temperatuur waarteen die dampdruk van 'n vloeistof gelyk aan die atmosferiese druk is. (2)

3.1.2 Gas ✓ (1)

3.1.3 Dipole-dipole ✓ (forces) / *Dipool-dipool (kragte)* (1)

3.1.4 **B** ✓
Compound **B** has larger molecular size ✓✓ / Compound **A** has a smaller molecular size
*Verbinding **B** het 'n groter molekulêre grootte / Verbinding **A** het 'n kleiner molekulêre grootte.* (3)

3.1.5 **A** ✓
Lower boiling point / ✓ *Laer kookpunt*

OR/*OF*

<u>B has a higher boiling point / *B het 'n hoër kookpunt*</u> (2)

3.1.6 Compound C/ HF has hydrogen bonds. ✓
HCℓ (A) and HBr (B) have dipole-dipole forces.

The hydrogen bonds / intermolecular forces in compound C / HF is stronger ✓than the dipole-dipole forces / intermolecular forces in HCℓ (A) and HBr (B).
Therefore more energy will be required to overcome the intermolecular forces in HF (A). ✓

Verbinding C/HF het waterstofbindings.
HCℓ (A) en HBr (B) het dipool-dipoolkragte.

Die waterstofbinding/intermolekulêrekragte in verbinding C / HF is sterker as die die dipool-dipoolkragte/intermolekulêrekragte in HCℓ (A) en HBr (B).
Daarom word meer energie benodig om die intermolekulêrekragte in HF (A te oorkom).

OR/*OF*

Compound C / HF has hydrogen bonds. ✓
HCℓ (A) and HBr (B) have dipole-dipole forces.
The dipole-dipole forces / intermolecular forces in compounds HCℓ (A) and HBr (B) is weaker ✓than the intermolecular forces in HF (C)
Therefore less energy will be required to overcome the intermolecular forces in HCℓ (A) and HBr (B). ✓

Verbinding C / HF het waterstofbindings
HCℓ (A) en HBr (B) het dipool-dipoolkragte

Die dipool-dipool/intermolekulêre kragte in verbindings HCℓ (A) en HBr (B) is swakker as die waterstofbinding/intermolekulêrekragte in HF (C).
Daarom word minder energie benodig om die intermolekulêrekragte in HCℓ (A) en HBr (B) te oorkom.

3.2 3.2.1 $CCℓ_4$ ✓ (1)

3.2.2 $CCℓ_4$ and I_2 have London forces only. ✓
H_2O has (London forces) and hydrogen bonds ✓
Intermolecular forces in solution are of comparable magnitude (CCl_4) ✓
OR IMF in solution are not of comparable magnitude (H_2O)
$CCℓ_4$ en I_2 het slegs Londenkragte
*H_2O het (londenkragte) en waterstofbindings **OF***
Intermolekulêrekragte in oplossing is van vergelykbare grootte. (3)
[16]

QUESTION 4/*VRAAG 4*

4.1 Charles' law ✓ / *Charles se wet* (1)

4.2 4.2.1 What effect will a change in <u>temperature</u> have on the <u>volume</u> of the gas? ✓✓/
What is the relationship between <u>temperature</u> and <u>volume</u> of gas?

Watter effek sal die verandering in <u>temperatuur</u> op die <u>volume</u> van die gas hê?
Wat is die verhouding tussen <u>temperatuur</u> en <u>volume</u> van die gas?

Marking guideline/*Nasienriglyn*
- Correct independent and dependent variable
- *Korrekte onafhanklike en afhanklike veranderlike*
- In the form of a question
- *In die vorm van 'n vraag*

(2)

4.2.2 Pressure OR the amount of gas.
Druk OF hoeveelheid gas
Any one/*Enige een* ✓ (1)

4.3 Thermometer/ *Termometer* ✓ (1)

4.4 4.4.1 $\frac{T_1}{V_1} = \frac{T_2}{V_2}$ ✓

$\frac{269}{66}$ ✓ $= \frac{T_2}{67}$ ✓

$T_2 = 273{,}08$ K

R = 273,08 ✓ (K) (4)

4.4.2 $n = \frac{m}{M}$

$n = \frac{132}{44}$ ✓

$n = 3$ mol

pV = nRT ✓

<u>p(66×10^{-3})</u> ✓ = <u>(3)(8,31)(269)</u> ✓

p = 101 608,64 Pa ✓ (5)

4.5 Low temperature ✓ and high pressure ✓/ *Lae temperatuur en hoë druk* (2)

4.6 H_2 ✓
H_2 has smaller molecules ✓ and weaker intermolecular forces ✓ /
H_2 het kleiner molekules en swakker intermolekulêrekragte. (3)
[19]

QUESTION 5/*VRAAG 5*

5.1 The minimum energy needed for a reaction to take place. ✓✓ /
Die minimum energie wat benodig word vir 'n reaksie om plaas te vind. (2)

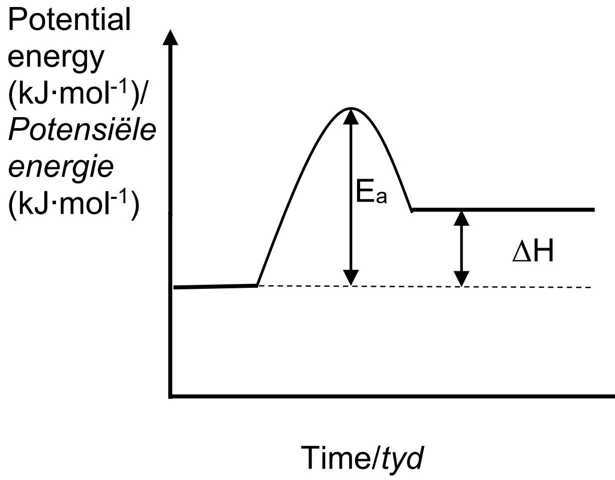
5.2 Reaction / *Reaksie* **I**. ✓
The temperature of the reaction mixture increases. ✓
Die temperatuur van die reaksiemengsel verhoog. (2)

5.3 NEGATIVE / *NEGATIEF* ✓ (1)

5.4 Catalyst / *Katalisator* ✓ (1)

5.5 LARGER THAN / *GROTER AS* ✓✓ (2)

5.6



Marking criteria / *Nasienkriteria*

Correct shape ✓
Korrekte vorm

ΔH correctly indicated ✓
ΔH korrek aangedui

E_a correctly indicated ✓
E_a korrek aangedui

(3)
[11]

QUESTION 6/*VRAAG 6*

6.1 6.1.1 The simplest whole number ratio of elements in a given compound ✓✓ /
Die eenvoudigste heelgetalverhouding van elemente in 'n gegewe verbinding (2)

6.1.2 $n(C) = \frac{m}{M}$ ✓

$n(C) = \frac{54,55}{12}$ ✓ = 4,55 mol

$n(H) = \frac{9,09}{1}$ ✓ = 9,09 mol

$n(O) = \frac{36,36}{16}$ ✓ = 2,27 mol

n (C) : n (H) : n (O)

$\frac{4,55}{2,27} : \frac{9,09}{2,27} : \frac{2,27}{2,27}$ ✓

2 : 4 : 1
Empirical formula / *Empiriese formule*: $C_2H_4O_1$ ✓ (6)

6.1.3 Ratio / *Verhouding* = $\frac{\text{molar mass}/\textit{molêre massa}}{\text{formula mass}/\textit{formule massa}}$

Ratio / *verhouding* = $\frac{88}{44}$ ✓

Ratio / *verhouding* = 2

Molecular formula / *Molekulêre formule*: $C_4H_8O_2$ ✓ (2)

6.2 6.2.1 The amount of solute per litre/volume of solution ✓✓ /
Die hoeveelheid opgeloste stof per liter/volume van oplossing (2)

6.2.2 $c = \frac{m}{MV}$ ✓

$c = \frac{8}{(40)✓(0,25)}$ ✓

$c = 0,8\ mol \cdot dm^{-3}$ ✓

n= m/M
= 8/40 ✓
= 0,2 mol

c = n/V
= 0,2/0,25 ✓
= $0,8\ mol.dm^{-3}$ ✓

for both formulae/ *vir beide formules*

Marking guide / *Nasienriglyn*

- Formula / *Formule* ✓ ✓
- Substitution of /*substitusie van* 8 and / *en* 0,25 or/ *of* 0,2 and 0,25
- Substitution of / *substitusie van* 40/
- Final answer / *Finale antwoord* ✓

(4)

6.3 NaN_3

$n = \frac{m}{M}$

$n = \frac{55}{65}$ ✓

$n = 0,85\ mol$

Mole ratio / *molverhouding*: $NaN_3 : N_2$
2 : 3

n (N_2) = $0,85 \times \frac{3}{2}$ ✓

n (N_2) = 1,275 mol

$V = nV_m$

V = (1,275)(22,4) ✓

V = 28,56 dm^3 ✓

Any one / *Enige een* ✓

(5)
[21]

QUESTION 7/*VRAAG 7*

7.1 The substance that is completely used-up in a chemical reaction. ✓✓ / *Die stof wat volledig in 'n chemiese reaksie opgebruik word.* (2)

7.2

<table>
<tr><td>H_2SO_4

$n = \frac{m}{M}$ ✓

$n = \frac{2000}{98}$ ✓

$n = 20{,}41\ \text{mol}$</td><td></td></tr>
<tr><td>Mole ratio / mol verhouding = $\frac{H_2SO_4}{NH_3}$

Mole ratio / mol verhouding = $\frac{1}{2}$ = 0,5 ✓

Mole ratio / mol verhouding
= $\frac{20{,}41}{58{,}82}$ ✓= 0,34

Ratio smaller than / Verhouding kleiner as 0,5.</td><td>OR / OF

Mole ratio / mol verhouding = $\frac{NH_3}{H_2SO_4}$

Mole ratio / mol verhouding
= $\frac{2}{1}$ = 2

Mole ratio / mol verhouding
= $\frac{58{,}82}{20{,}41}$ = 2,88

Ratio greater than / Verhouding groter as 2.</td></tr>
<tr><td colspan="2">H_2SO_4 is the limiting reagent / H_2SO_4 is die beperkende reagens.</td></tr>
</table>

n [$(NH_4)_2SO_4$]= $20{,}41 \times \frac{1}{1}$ = 20,41 ✓

m = nM

m = (20,21)(132) ✓

m = 2 667,72 g ✓ (7)

[9]

QUESTION 8/*VRAAG 8*

8.1 8.1.1 A base is a proton/H^+ ion acceptor. ✓✓ /
'n Basis is 'n protoon/H^+ ioon-aanvaarder (2)

8.1.2 HPO_4^{2-} and/en PO_4^{3-}✓ **OR/OF** H_3O^+ and/en H_2O (1)

8.1.3 ACIDIC / SUUR. ✓
(Excess)/ (*Oormaat)* H_3O^+ ✓ are produced / *word geproduseer.* (2)

8.1.4 HPO_4^2 ✓✓ (2)

8.2 $CuO + 2HNO_3$✓ $\longrightarrow$ $Cu(NO_3)_2 + H_2O$✓ ✓Balancing / *Balansering*

Marking guide/ *Nasienriglyn*
- Reactants / *Reaktante*
- Products / *Produkte*
- Balancing / *Balansering*

(3)

8.3 8.3.1

Marking guide / *Nasienriglyn*
- Formula / *Formule* n = cV
- Substitution into / *Substitusie in* n= cV
- Ratio / *Verhouding* $CaCO_3$: H_2SO_4aCO3: H2SO4
- Formula / *Formule* n= m/M
- Substitution / *Substitusie* of 100 into n = m/M
- Calculation of / *Berekening van* % Purity */ Suiwerheid*
- Final answer / *Finale antwoord*

$n_{\text{acid reacting / suur wat reageer het}}$= cV ✓
= 1,5 x 200/1000 ✓
= 3 mol
M ($CaCO_3$) used / *gebruik* = nM ✓
= 3 x 100 ✓
= 30 g
% Purity/ Suiwerheid = $m_{pure/suiwer}/m_{impure/onsuiwer}$ x 100
= 30/40 x 100 ✓
= 75% ✓ (6)

8.3.2 $c_1V_1 = c_2V_2$
9 x 10 ✓ = 1,5 ✓V
60 cm^3 = $V_{\text{solution / oplossing}}$
V_{water} = 60 –10 ✓
= 50 cm^3 ✓ (4)
[20]

QUESTION 9/*VRAAG 9*

9.1 9.1.1 Loss of electrons ✓✓ / *Verlies van elektrone* (2)

9.1.2 Zn ✓✓ (2)

9.1.3 $Fe^{3+} + e^- \rightarrow Fe^{2+}$ ✓✓ (2)

9.2 9.2.1 + 5 ✓✓ (2)

9.2.2 $Ag (s) \rightarrow Ag^+ (aq) + e^-$ ✓

$NO_3^- (aq) + 2 H^+ + e^- \rightarrow NO_2 (g) + H_2O$ ✓

$Ag (s)\ NO_3^- (aq) + 2 H^+ \rightarrow Ag^+ (aq) + NO_2 (g) + H_2O$ ✓✓

<u>Marking guideline/ *Nasienriglyn*</u> Correct oxidation half reaction / *Korrekte oksidasie halfreaksie* Correct reduction half reaction / *Korrekte reduksie halfreaksie* Final reaction correct / *Finale reaksie korrek* Balanced / *Gebalanseerd*

(4)
[12]

QUESTION 10/*VRAAG 10*

10.1 10.1.1 Witwatersrand ✓ (1)

10.1.2 Reduced ✓ / *Gereduseer/verminder*

<u>Oxidation number (of Au) decreases</u> ✓✓ (from +1 to 0) /
<u>Oksidasiegetal (van Au) verlaag</u> (vanaf +1 tot 0) (3)

10.1.3 NaCN is harmful as it is <u>poisonous</u> to humans ✓✓ /
NaCN is skadelik omdat dit <u>giftig</u> is vir mense (2)

10.1.4 Smelting ✓ (1)

10.2 10.2.1 Release of greenhouse gas / CO_2 / Global warming ✓
Air pollutions/toxins released into air. ✓

Vrystelling van kweekhuisgas / CO_2 / Aardverwarming /
Lugbesoedeling / gifstowwe wat in die lug vrygestel word. (2)
[9]

TOTAL/*TOTAAL*: 150