Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2016

PHYSICAL SCIENCES P2

MARKS: **150**

TIME: **3 hours**

IPHSCE2

This question paper consists of 15 pages including 2 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 EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number your answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, 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. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions et cetera where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 A Lowry-Bronsted base is a substance that …

A donates a proton.
B accepts a proton.
C donates an electron.
D accepts an electron. (2)

1.2 Nitrogen gas, $N_2(g)$, is cooled until it turns into liquid nitrogen, $N_2(\ell)$.

What type of intermolecular forces exist between nitrogen molecules in the liquid phase?

A Ionic bonds
B Ion-dipole forces
C Dipole-dipole forces
D Induced dipole forces or dispersion forces or London forces (2)

1.3 How many valence electrons are in one atom of lithium?

A 1
B 2
C 3
D 4 (2)

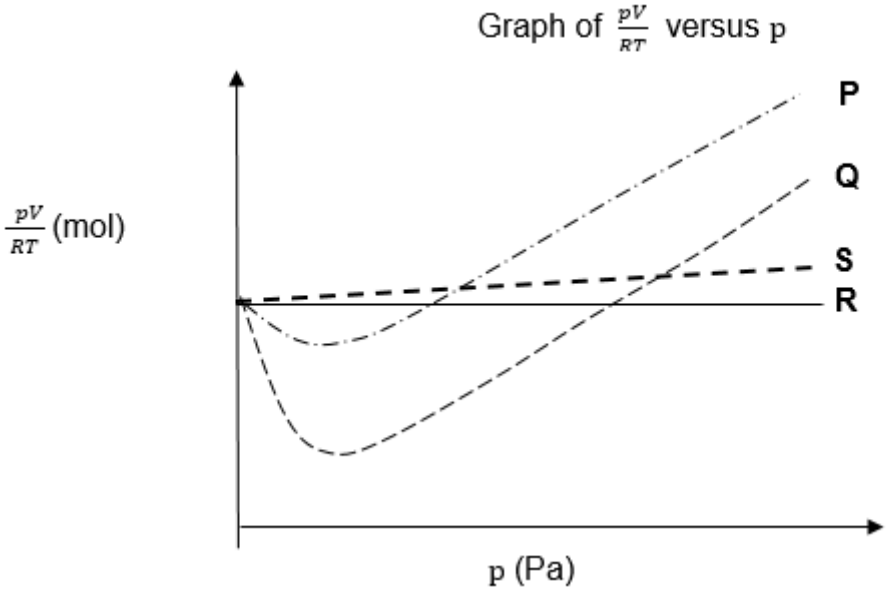
1.4 Which ONE of the following equations represents a REDOX reaction?

A $S + O_2 \rightarrow SO_2$
B $AgNO_3 + KI \rightarrow AgI + KNO_3$
C $NaOH + HC\ell \rightarrow NaC\ell + H_2O$
D $Na_2CO_3 + 2HC\ell \rightarrow 2NaC\ell + CO_2 + H_2O$ (2)

1.5 Which ONE of the following correctly defines pressure exerted by a gas?

A Average kinetic energy of gas particles
B Number of particles filling the container
C Collisions of gas particles with each other
D Collisions of gas particles with the walls of the container (2)

1.6 In the diagram below, **R** the solid line, represents graph of $\frac{pV}{RT}$ versus p for ONE mole of an ideal gas. The other graphs **P**, **Q** and **S** are for ONE mole of each of the gases CH_4, He and NH_3 in random order.



Identify the gases whose behaviour is represented by graph **P**, **Q** and **S**.

	P	**Q**	**S**
A	He	CH_4	NH_3
B	NH_3	He	CH_4
C	NH_3	CH_4	He
D	CH_4	NH_3	He

(2)

1.7 The chemical analysis of a compound with molecular formula, $C_xH_{2x}O_2$ where **x** is the number of carbon atoms in one molecule of the compound shows that it contains 12,5% oxygen (O) by mass.

The percentage by mass of carbon (C) in the compound is …

A 75%.
B 25%.
C 12,5%.
D 87,5%. (2)

1.8 Ozone(O_3) decomposes to form oxygen gas(O_2) according to the equation:

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

Which ONE of the following is NOT CORRECT about the equation for the reaction?

According to the equation …

A 2 moles of O_3 decompose to produce 3 moles of O_2.
B 2 grams of O_3 decompose to produce 3 grams of O_2.
C 96 grams of O_3 decompose to produce 96 grams of O_2.
D $1,204x10^{24}$ molecules of O_3 decompose to produce $1,806x10^{24}$ molecules of O_2. (2)

1.9 Consider the reaction represented by the equation below:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g) \qquad \Delta H = -469kJ/mol$$

The total energy absorbed when bonds are broken in TWO moles of H_2 and ONE mole of O_2 is 1 371 kJ/mol.

What is the bond energy in kJ/mol for each O-H bond in the water molecule?

A 920
B 499
C 460
D 1840 (2)

1.10 Which properties of gold make it useful for the electrical circuits of electrical and electronic devices?

A Malleability and ductility
B Good ductility and conductivity
C Malleability and heat ray reflector
D Shiny appearance and good ductility (2)

[20]

QUESTION 2 (Start on a new page.)

Consider the TWO compounds BF_3 and NH_3.

2.1 Both BF_3 and NH_3 have the same type of intra-molecular forces (interatomic bonds).

2.1.1 Write down the NAME of these intra-molecular forces. (1)

2.1.2 Explain how these intra-molecular forces in QUESTION 2.1.1 are formed. (1)

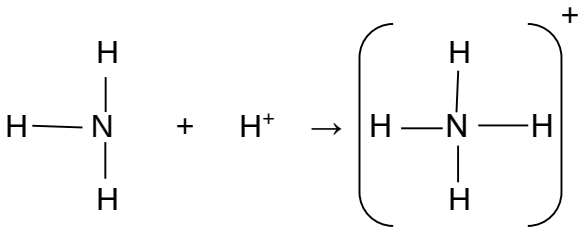
2.2 Give the LEWIS diagrams for:

2.2.1 BF_3 (2)

2.2.2 NH_3 (2)

2.3 Compare the polarity of the BF_3 and NH_3 molecules by referring to the POLARITY OF THE BONDS and the EFFECT of the SHAPE of EACH MOLECULE on its polarity. (5)

2.4 A type of bond is formed between the nitrogen atom (N) in a molecule of ammonia (NH_3) with the hydrogen ion (H^+) as shown below.



2.4.1 Write down the NAME of the bond formed between the nitrogen atom and the H^+ ion. (1)

2.4.2 Give a reason why the oxygen atom (O) in the water molecule is able to form the type of bond mentioned in QUESTION 2.4.1 with the H^+ ion. (2)

[14]

QUESTION 3 (Start on a new page.)

3.1 Water has extra ordinary macroscopic properties, for example density of ice is different from that of liquid water.

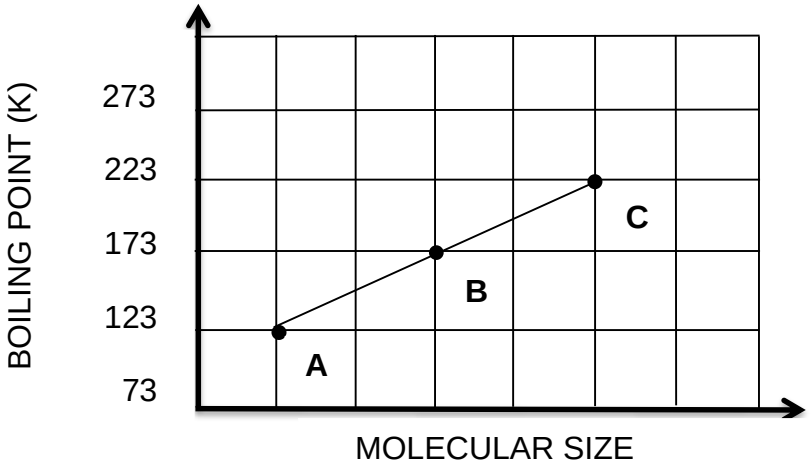
3.1.1 Write down the NAME of intermolecular forces between water molecules responsible for the difference in the density of liquid water and ice. (1)

3.1.2 Explain how the difference in the density of ice and liquid water protects aquatic life at extremely low temperatures. (2)

3.1.3 Calculate the number of water molecules in 1 dm^3 of water at 25 °C. The density of water is 1 g/cm^3 at 25 °C. (4)

3.1.4 Explain why coastal areas experience moderate temperatures compared to inland areas. (2)

3.2 The graph of molecular size versus the boiling point is given below. The letters **A**, **B** and **C** represent the compounds CH_4, C_2H_6 and C_3H_8 respectively.



3.2.1 Describe the trend in the boiling points of the compounds as shown by the graph. (2)

3.2.2 Explain the answer to QUESTION 3.2.1 by referring to MOLECULAR SIZE, TYPE and STRENGTH of INTERMOLECULAR FORCES. (3)

3.2.3 Which ONE of the compounds (**A, B** or **C**) has the HIGHEST melting point? (1)

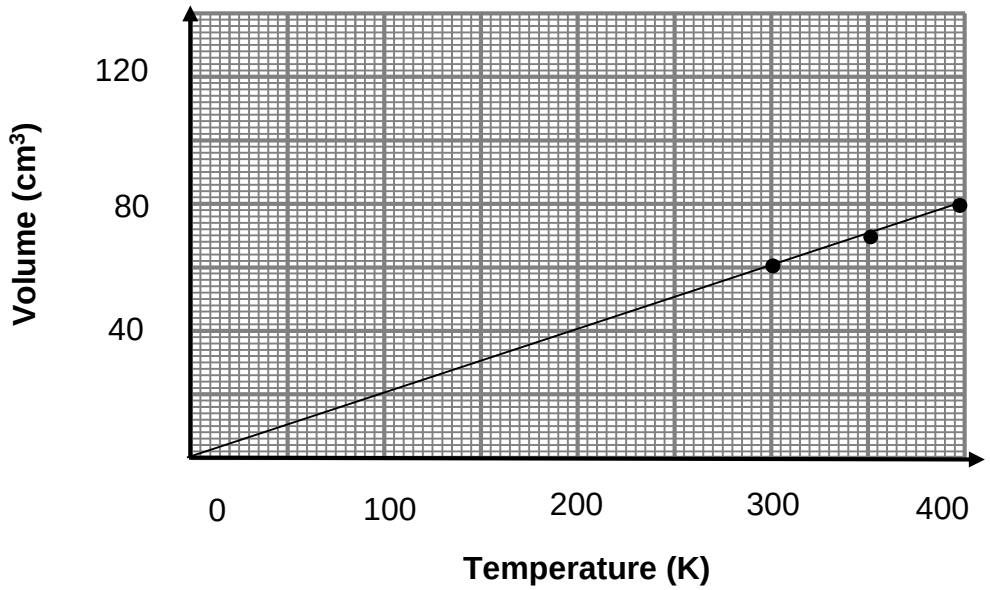
3.3 Consider the molecules NH_3 and PH_3.
NH_3 has a smaller molecular mass and similar shape as PH_3. The boiling point of NH_3 is -33 ºC and that of PH_3 is -87,4 ºC.

Explain the difference in the boiling points by referring to the TYPE and STRENGTH of INTERMOLECULAR FORCES. (3)
[18]

QUESTION 4 (Start on a new page.)

4.1 A group learners conducted an investigation to verify the relationship between volume and temperature of a gas. They filled a syringe with hydrogen gas and placed the syringe in water baths at different temperatures.
They recorded the results which they used to plot the graph below.

Graph of Volume versus Temperature



4.1.1 Name the quantity which is defined as a measure of the average kinetic energy of gas molecules. (1)

4.1.2 Use the information from the graph and:

(a) Determine the volume (in cm^3) of the gas when the temperature is 27 °C (2)

(b) Write down the learners' conclusion (2)

4.1.3 Write down TWO variables that must be kept constant during the investigation. (2)

4.1.4 Write down the NAME of an apparatus that was used to measure the values of the independent variable in this investigation. (1)

4.1.5 Explain why real gases deviate from ideal gas behaviour at low temperatures. (3)

4.2 2,04 g of a gas occupies a volume of 2 dm^3 at 27 °C and 150 kPa.

Calculate the molar mass of the gas. (6)

4.3 In the diagram below a syringe is filled with gas **A** while the other syringe contains gas **B**. The volume, temperature and mass of the contents of the syringes are the same. The pressure of gas **A** is *twice* that of gas **B**.

How does the *molar mass of gas* **B** compare with the molar mass of gas **A**? Write only HIGHER, LOWER or THE SAME. Explain the answer. (3)

[20]

QUESTION 5 (Start on a new page.)

5.1 In order to determine the empirical and molecular formula of a compound, C_xH_y, a certain mass of the compound is burnt completely in excess oxygen to produce 47,1 g CO_2 and 19,35 g H_2O as the only products.

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

5.1.2 Use relevant calculations to determine the empirical formula of the compound. (8)

5.1.3 The molar mass of the compound is 28 g.mol^{-1}. Determine by using calculations the values of **x** and **y**. (2)

5.2 A sample of IMPURE calcium carbonate (limestone) of unknown mass required a continuous supply of strong heat to decompose according to the following equation:

$$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$$

After the completion of reaction, 11,76 g CaO was produced.
The percentage purity of calcium carbonate is found to be 80%.

5.2.1 Calculate the mass of the impure calcium carbonate. (6)

5.2.2 Sketch a potential energy diagram for the above reaction. Clearly indicate the axes and indicate the following on the graph: (No values are required.)

- ΔH
- Reactants(R) and Products (P)
- Activation energy (EA)
- Activated complex (X) (5)

[23]

QUESTION 6 (Start on a new page.)

6.1 The hydrogen sulphate ion (HSO_4^-) can act as both an acid and a base. It reacts with water according to the balanced equation:

$$HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$$

Write down:

6.1.1 A term for the underlined phrase (1)

6.1.2 The FORMULAE of the TWO acids in the reaction (2)

6.2 A solution of potassium hydroxide (KOH) is prepared by dissolving 3,36 g crystals of KOH in 250 cm^3 of solution.

Calculate the concentration of the potassium hydroxide solution. (4)

6.3 25 cm^3 of a potassium hydroxide solution of concentration 0,25 $mol.dm^{-3}$ completely neutralises a dilute solution of sulphuric acid (H_2SO_4) in a flask.

The incomplete equation below represents the reaction that takes place:

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + \mathbf{Y}$$

6.3.1 Write down the NAME the salt formed. (1)

6.3.2 Write down the FORMULA of compound **Y**. (1)

6.3.3 Calculate the mass of sulphuric acid in the flask. (5)

[14]

QUESTION 7 (Start on a new page.)

7.1 The following equation represents a redox reaction in which 8 grams of iron (III) oxide (Fe_2O_3) reacts with 3,8 grams of aluminium (Aℓ).

$$Fe_2O_3 + 2A\ell \rightarrow A\ell_2O_3 + 2Fe$$

7.1.1 Define the term *reduction* in terms of electron transfer. (2)

7.1.2 Write down the formula or symbol of the substance that is the reducing agent. Justify your answer by making use of oxidation numbers. (4)

The reaction runs to completion.

7.1.3 Calculate the percentage yield if 4,76 g of Fe was formed. (7)

7.2 Butane (C_4H_{10}) gas reacts COMPLETELY with 4,48 dm^3 of oxygen (O_2) at STP according to the equation.

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)$$

Calculate the number of molecules of butane reacting. (5)

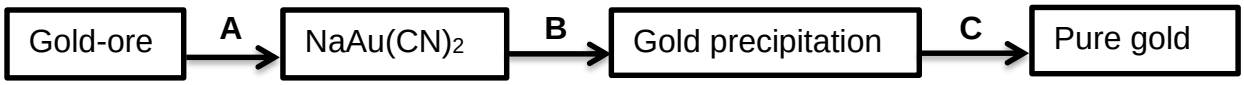
7.3 Consider the following reaction:

$$NO_3^- + H_2S \rightarrow S + NO + H_2O \quad \text{(in an acid medium)}$$

Balance the equation by using ion-electron method. (7)
[25]

QUESTION 8 (Start on a new page.)

The following diagrams show the most important steps during the recovery of gold from the ore.



8.1 8.1.1 Define the term *ore*. (2)

8.1.2 Write down the NAME of the type of mining used to recover gold. (1)

The incompletely balanced reaction is taking place during **process A**:

$$4Au + NaCN + O_2 + 2H_2O \rightarrow NaAu(CN)_2 + 4NaOH$$

8.2 Is the reaction in **process A** a REDOX, ACID-BASE or PRECIPITATION reaction? (1)

8.3 Balance the above equation by inspection. (2)

8.4 Write down the FORMULA of the oxidising agent. (2)

8.5 Is the solution formed during **process A** ACIDIC, ALKALINE or NEUTRAL? Give a reason for your answer. (2)

A transition element is added during **process B** to displace gold from $NaAu(CN)_2$.

8.6 Write down the NAME or SYMBOL of the element. (1)

8.7 Why is it important to send gold into a hot furnace? (1)

8.8 Name TWO reasons why the gold mining industry is so important to the South African economy. (2)

8.9 Write TWO negative impacts that gold mining industry has on water in the environment. (2)

[16]

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*
Avogadro's constant Avogadro se konstante	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Molar gas constant *Molêre gaskonstante*	R	$8.31\ J \cdot K^{-1} \cdot mol^{-1}$
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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	$pV = nRT$
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$n = \frac{V}{V_M}$	$c = \frac{n}{V}$ OF/OR $c = \frac{m}{MV}$

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

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2.0 5 B 11	2,5 6 C 12	3.0 7 N 14	3,5 8 O 16	4.0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1.5 13 Aℓ 27	1.8 14 Si 28	2.1 15 P 31	2,5 16 S 32	3.0 17 Cℓ 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1,6 23 V 51	1,6 24 Cr 52	1.5 25 Mn 55	1.8 26 Fe 56	1.8 27 Co 59	1.8 28 Ni 59	1.9 29 Cu 63,5	1.6 30 Zn 65	1.6 31 Ga 70	1.8 32 Ge 73	2.0 33 As 75	2,4 34 Se 79	2.8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1,4 40 Zr 91	41 Nb 92	1,8 42 Mo 96	1.9 43 Tc	2.2 44 Ru 101	2.2 45 Rh 103	2.2 46 Pd 106	1.9 47 Ag 108	1.7 48 Cd 112	1.7 49 In 115	1.8 50 Sn 119	1.9 51 Sb 122	2,1 52 Te 128	2,5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 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	1.8 81 Tℓ 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2,5 85 At	86 Rn
0,7 87 Fr	0,9 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*