basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2014

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 2 data sheets.

IPHSCE2

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of ELEVEN 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. 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 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.

1.1 A substance that donates electrons during a chemical reaction is a/an …

A Arrhenius acid.

B Arrhenius base.

C reducing agent.

D oxidising agent. (2)

1.2 Which ONE of the following species contains a dative covalent bond?

A NH_3

B CH_4

C H_3O^+

D NF_3 (2)

1.3 Which ONE of the following compounds has dipole-dipole forces between their molecules?

A CO_2

B $HC\ell$

C $C\ell_2$

D $CC\ell_4$ (2)

1.4 Consider the following chemical reaction:

$$HCO_3^- + HC_2O_4^- \rightleftharpoons H_2CO_3 + C_2O_4^{2-}$$

Which ONE of the following CORRECTLY identifies the order of Lowry-Brönsted acids and bases in the above reaction?

A Base, acid, acid, base

B Acid, base, base, acid

C Acid, base, acid, base

D Base, acid, base, acid (2)

1.5 Which ONE of the following represents the greatest mass?

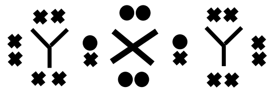
A One chlorine atom

B One chlorine molecule

C One mole of chlorine

D One gram of chlorine (2)

1.6 Consider the Lewis structure of a compound below:



Which ONE of the following is CORRECT?

	Name of element X	Name of element Y	Molecular shape of compound
A	Chlorine	Oxygen	Angular
B	Oxygen	Chlorine	Linear
C	Chlorine	Sulphur	Linear
D	Sulphur	Chlorine	Angular

(2)

1.7 Consider the reaction represented by the equation below:

$$2Fe(s) + 3CO_2(g) \rightarrow Fe_2O_3(s) + 2CO(g) \qquad \Delta H = + 53,2\ kJ$$

Which ONE of the following statements is TRUE?

For each mole of Fe that reacts, …

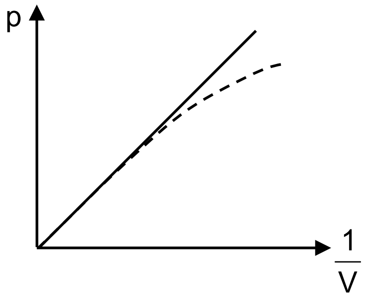
A 26,6 kJ of energy are released.

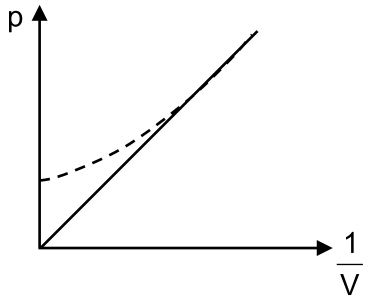
B 26,6 kJ of energy are absorbed.

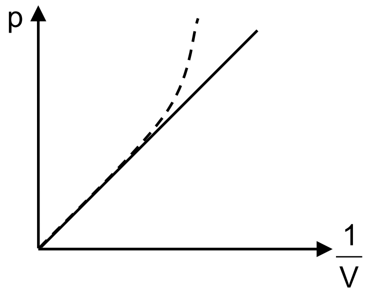
C 53,2 kJ of energy are released.

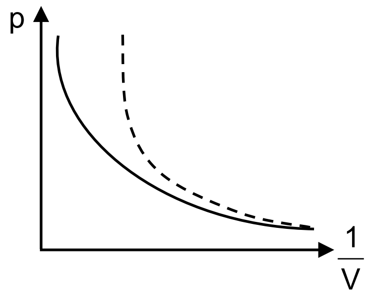
D 53,2 kJ of energy are absorbed. (2)

1.8 In which ONE of the following graphs does the dotted line CORRECTLY represent the deviation of a real gas from ideal gas behaviour?

A


B


C


D


(2)

1.9 10 moles of hydrogen gas (H_2) and 2,5 moles of nitrogen gas (N_2) are mixed and allowed to react to form ammonia (NH_3) according to the following balanced equation:

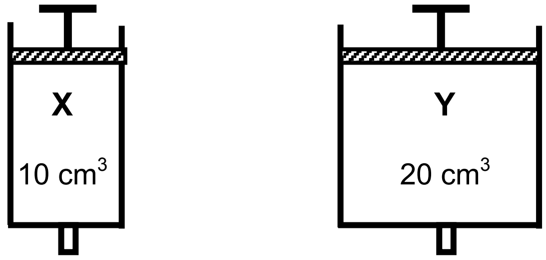
$$3H_2(g) + N_2(g) \rightarrow 2NH_3(g)$$

If 4 moles of $NH_3(g)$ is formed during the reaction, the number of moles of $H_2(g)$ and $N_2(g)$ that remain in the container are respectively:

	Moles of $H_2(g)$	**Moles of $N_2(g)$**
A	0	0
B	7	1,5
C	4	0,5
D	4	2

(2)

1.10 Two gas syringes, **X** and **Y**, each contains the same gas at STP. The volume of syringe **X** is 10 cm^3 and that of syringe **Y** is 20 cm^3 as shown below. Assume ideal gas behaviour.



Which ONE of the following statements is CORRECT?

A The average kinetic energy of the molecules in **X** is less than that of the molecules in **Y**.

B The total kinetic energy of the molecules in **X** is less than that of the molecules in **Y**.

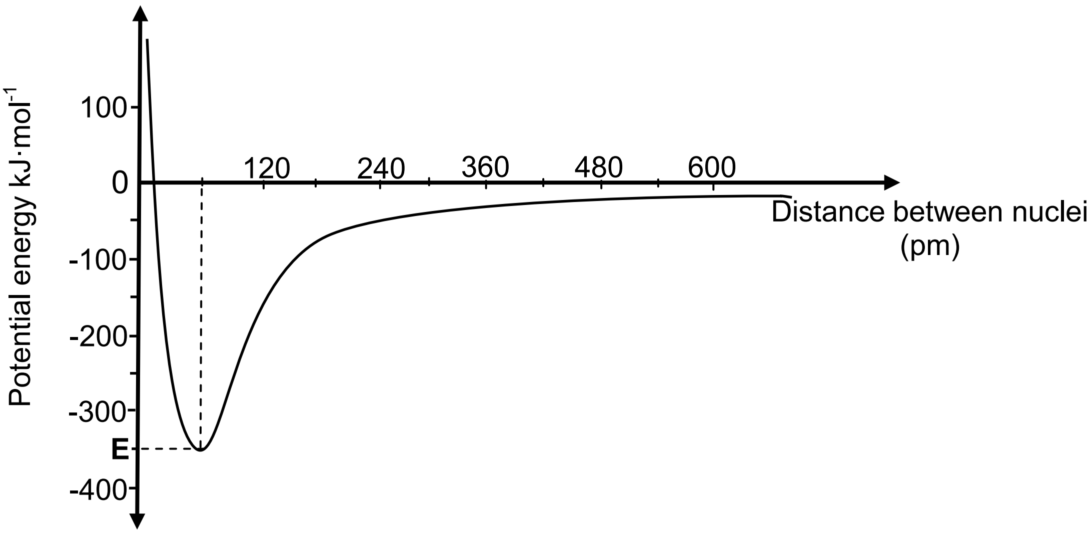
C The number of gas molecules in **X** is equal to the number of gas molecules in **Y**.

D The product pV in **X** is equal to the product pV in **Y**. (2)

[20]

QUESTION 2 (Start on a new page.)

The graph below shows the change in energy that takes place when a hydrogen (H) atom approaches a bromine (Br) atom.



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

2.2 From the graph, write down the:

2.2.1 Bond length, in pm, of the H-Br bond (2)

2.2.2 Energy, in kJ·mol^{-1}, needed to break the H-Br bond (2)

2.2.3 Name of the potential energy represented by **E** (1)

2.3 How will the bond length of an H-F bond compare to that of the H-Br bond?

Write down EQUAL TO, SHORTER THAN or LONGER THAN. Give a reason for the answer. (2)

[9]

QUESTION 3 (Start on a new page.)

Both aluminium fluoride ($A\ell F_3$) and phosphorous trifluoride (PF_3) contain fluorine. Aluminium fluoride is a colourless solid used in the production of aluminium, whilst phosphorous trifluoride is a poisonous, colourless gas.

3.1 Explain the difference between a *covalent bond* and an *ionic bond*. (2)

3.2 Name the type of chemical bond between particles in:

3.2.1 $A\ell F_3$ (1)

3.2.2 PF_3 (1)

3.3 Draw the Lewis structures for:

3.3.1 $A\ell F_3$ (3)

3.3.2 PF_3 (2)

3.4 Write down the molecular shape of PF_3. (1)

3.5 The melting point of $A\ell F_3$ is 1 291 °C and that of PF_3 is -151 °C.

Fully explain this difference in melting point. (4)
[14]

QUESTION 4 (Start on a new page.)

The boiling points of four compounds of hydrogen, represented by the letters **P**, **Q**, **R** and **S**, are given in the table below.

	Formula	**Boiling point (°C)**
P	CH_4	-164
Q	NH_3	-33
R	H_2O	100
S	SiH_4	-112

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

4.2 Fully explain the difference in boiling points between compound **P** and:

4.2.1 Compound **Q** (3)

4.2.2 Compound **S** (3)

4.3 Explain why the boiling points of compounds **Q** and **R** differ by referring to ELECTRONEGATIVITY and DEGREE OF POLARITY. (2)

4.4 Write down the letter from the table that represents the following:

4.4.1 ONE polar compound (1)

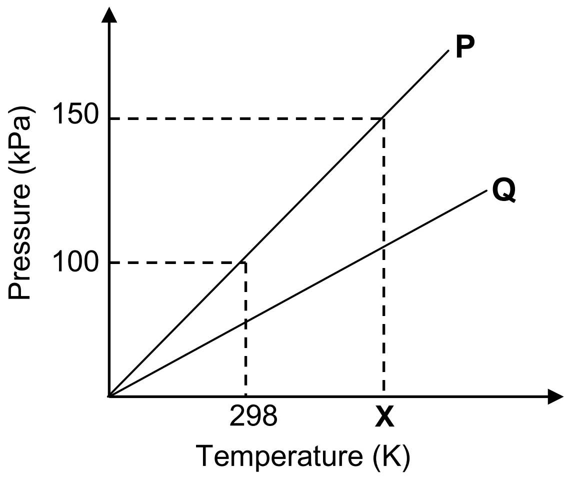
4.4.2 ONE non-polar compound (1)
[12]

QUESTION 5 (Start on a new page.)

5.1 Explain what is meant by the term *temperature of a gas.* (1)

5.2 Two learners investigate the relationship between the temperature and the pressure of an enclosed gas. The learners use different samples of the same gas in two identical containers of fixed volumes.

Graph **P** and Graph **Q** below represent the results obtained by the learners.



5.2.1 State Guy Lussac's law in words. (2)

5.2.2 Use the law in QUESTION 5.2.1 to determine the value of temperature **X**, shown on the graph, in °C. (4)

5.2.3 Explain, using the relevant formulae, why graph **Q** has a smaller gradient than graph **P**. (4)

5.3 A certain gas with a mass of 2,2 g occupies a volume of 0,831 dm^3 at 27 °C and pressure 150 kPa.

5.3.1 Calculate the molar mass of the gas. Assume that the gas behaves like an ideal gas. (6)

5.3.2 Write down the MOLECULAR FORMULA or NAME of the gas in QUESTION 5.3.1. (1)

[18]

QUESTION 6 (Start on a new page.)

6.1 Define the term *molar mass* of a substance. (1)

6.2 Calculate the number of moles of water in 100 g of water. (3)

6.3 Methyl benzoate is a compound used in the manufacture of perfumes. It is found that a 5,325 g sample of methyl benzoate contains 3,758 g of carbon, 0,316 g of hydrogen and 1,251 g of oxygen.

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

6.3.2 Determine the empirical formula of methyl benzoate. (7)

6.3.3 If the molar mass of methyl benzoate is 136 $g \cdot mol^{-1}$, what is its molecular formula? (2)

[15]

QUESTION 7 (Start on a new page.)

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

7.2 Iron (Fe) reacts with sulphur (S) to form iron sulphide (FeS) according to the following balanced equation:

$$Fe(s) + S(s) \rightarrow FeS$$

7.2.1 Calculate which of the two substances will be used up completely if 20 g of Fe and 10 g of S are mixed and heated. (5)

7.2.2 How many grams of the other substance are in excess? (2)

7.3 Magnesium burns in air to form magnesium oxide according to the following balanced equation:

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

If the percentage yield of this reaction is only 80%, calculate the mass of magnesium that needs to be burned to produce 30 g of magnesium oxide. (6)

[15]

QUESTION 8 (Start on a new page.)

Hydrogen gas and oxygen gas react to form water according to the following balanced equation:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g) + 241{,}8\ kJ\cdot mol^{-1}$$

The activation energy (E_A) for this reaction is 1 370 $kJ\cdot mol^{-1}$.

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

8.2 Sketch a potential energy versus reaction coordinate graph for the above reaction. Clearly label the axes and indicate the following on the graph:

- ΔH
- E_A for the forward reaction
- Reactants (**R**) and products (**P**)
- Activated complex (**X**) (5)

8.3 Write down the value of the:

8.3.1 Heat of reaction (1)

8.3.2 Activation energy for the following reaction:

$2H_2O(g) \rightarrow 2H_2(g) + O_2(g)$ (2)

[10]

QUESTION 9 (Start on a new page.)

9.1 Limestone, or sometimes ash, is used in pit latrines (long drops) to neutralise acidic waste.

Limestone reacts with hydrochloric acid according to the following UNBALANCED equation:

$$CaCO_3(s) + HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

9.1.1 Define an *acid* in terms of the Arrhenius theory. (2)

9.1.2 Is ash acidic or basic? (1)

9.1.3 Rewrite the above equation into your ANSWER BOOK and then balance the equation. (1)

9.2 Sulphuric acid reacts with water in two steps as represented by the equations below.

Equation **I**: $H_2SO_4(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_4^-(aq)$

Equation **II**: $HSO_4^-(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + SO_4^{2-}(aq)$

9.2.1 Define the term *ampholyte*. (2)

9.2.2 Write down the FORMULA of a species that acts as ampholyte in the above reactions. (1)

9.2.3 Write down the NAME of the conjugate base of the hydrogen sulphate ion. (1)

9.3 A standard sodium carbonate solution is prepared in a 250 cm^3 volumetric flask.

During a titration, 20 cm^3 of a 0,1 $mol{\cdot}dm^{-3}$ nitric acid solution neutralises 25 cm^3 of the above standard solution according to the following balanced equation:

$$2HNO_3(aq) + Na_2CO_3(aq) \rightarrow 2NaNO_3(aq) + H_2O(\ell) + CO_2(g)$$

9.3.1 Write down the NAME of the salt formed in the above reaction. (1)

9.3.2 Calculate the mass of sodium carbonate used to prepare the standard solution in the volumetric flask. (5)

[14]

QUESTION 10 (Start on a new page.)

Nitric acid and copper reacts according to the following unbalanced equation:

$$HNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + NO_2(g) + H_2O(\ell)$$

10.1 Define *reduction* in terms of oxidation numbers. (2)

10.2 For this reaction, write down the FORMULA of the:

10.2.1 Substance that is oxidised (1)

10.2.2 Reducing agent
Allocate oxidation numbers to the relevant species and then explain the answer. (3)

10.2.3 Oxidising agent
Explain the answer in terms of electron transfer. (2)

10.3 Balance the equation using the ion-electron method. Show the oxidation and reduction half-reactions during the balancing. (5)
[13]

QUESTION 11 (Start on a new page.)

Mining has been the main driving force behind the history and development of South Africa. Diamond and gold production may now be well down from their peaks, though South Africa is still number 5 in gold. It is the world's largest producer of chrome, manganese, platinum and vanadium, as well as the world's third largest coal exporter. In 2012 South Africa overtook India to become the world third biggest iron ore supplier to China, the world's largest consumer of iron ore.

11.1 Choose from the list below the mining activity that you have studied and then answer the questions that follow.

gold; iron; phosphate; coal; diamonds; copper; platinum;
zinc; chromium; asbestos; manganese

11.1.1 What is the location of the major mining activity in South Africa? (1)

11.1.2 What type of mining is used to recover the selected mineral? (1)

11.2 Mining has advantages and disadvantages.

11.2.1 Give TWO reasons why the mining industry is so important to the South African economy. (2)

11.2.2 Write down TWO negative impacts that mining has on the environment. (2)

11.3 A large deposit of a precious metal is discovered in South Africa.

Write down TWO factors which have to be considered before developing the site for mining. (4)
[10]

TOTAL: 150

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*

NAME/*NAAM*	**SYMBOL/*SIMBOOL***	**VALUE/*WAARDE***
Avogadro's constant *Avogadro-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 by STD*	V_m	$22{,}4\ dm^{3} \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

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

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

KEY/*SLEUTEL*

	Electronegativity / *Elektronegatiwiteit*	Atomic number / *Atoomgetal*	Symbol / *Simbool*	Approximate relative atomic mass / *Benaderde relatiewe atoommassa*
Example	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