higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE
(Second paper)
NQF LEVEL 3

(10021003)

4 December 2020 (Y-paper)
13:00–16:00

Nonprogrammable scientific calculators may be used.

This question paper consists of 10 pages, 1 information sheet and 1 periodic table

311Q2N2004

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TIME: 3 HOURS
MARKS: 150

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Write your EXAMINATION NUMBER and the CENTRE NUMBER in the appropriate spaces on the ANSWER BOOK.
5. Show the formulae and substitutions in all calculations.
6. Approximate all final answers accurately to TWO decimals.
7. Start each section on a new page.
8. Write neatly and legibly.

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SECTION A

QUESTION 1

Give ONE term for each of the following descriptions by writing it next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 Measure of how much force is applied to a material

1.2 Type of bond in a molecule where the bonding electrons are equally shared

1.3 Chemical mist made up of water vapour and pollutants

1.4 Difference between the potential energy of products and reactants

1.5 Force per area exerted by air particles in the atmosphere

(5 × 1) **[5]**

QUESTION 2

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

COLUMN A		COLUMN B	
2.1	Gas produced when $KC\ell O_3$ decomposes	A	CO_2
2.2	Most significant greenhouse gas	B	endothermic
2.3	Polar substance	C	plasticity
2.4	Permanent deformation without breaking	D	elasticity
2.5	Reaction in which there is a drop-in temperature	E	O_2
		F	H_2O
		G	allotrope of CO
		H	exothermic
		I	O_3

(5 × 1) **[5]**

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QUESTION 3

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.1–3.5) in the ANSWER BOOK.

3.1 Dry ice is solid because the intermolecular forces are extremely strong.

3.2 The bubbles formed when water boils contain hydrogen and oxygen.

3.3 There are two sulphate ions in one molecule of $A\ell_2(SO_4)_3$.

3.4 In methane (CH_4), the C–H bond is nonpolar because the electronegativity difference between C and H is less than 0,9.

3.5 A white precipitate is formed when silver nitrate is added to a solution of sodium chloride.

(5 × 2) **[10]**

QUESTION 4

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 number (4.1–4.5) in the ANSWER BOOK.

4.1 In a chemical reaction the potential energy of the products is 50 kJ.

What is potential energy of the reactants if the net amount of energy given off is 95 kJ?

A 145 kJ
B -145 kJ
C 45 kJ
D -45 kJ

4.2 Which ONE of the following metals is the least reactive?

A Potassium
B Lithium
C Magnesium
D Copper

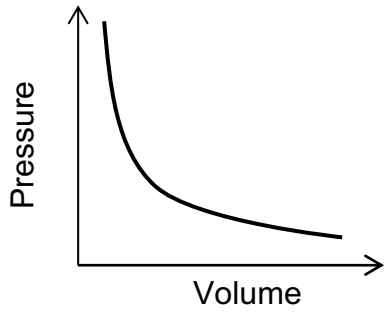
4.3 Which ONE of the following molecules has the most polar chemical bond(s)?

A $HC\ell$
B HF
C NH_3
D H_2O

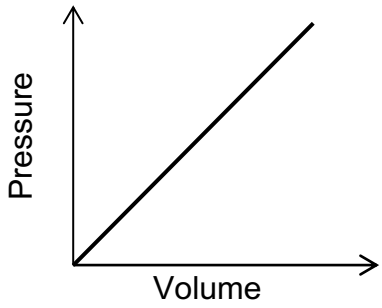
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4.4 Which ONE of the following graphs correctly represents Boyle's law?

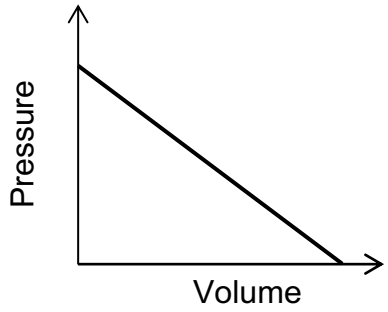
A



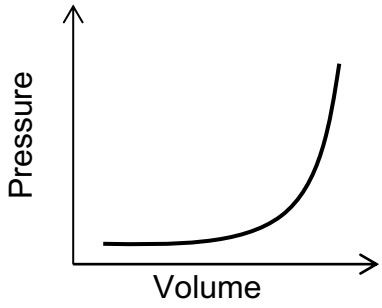
B



C



D



4.5 Which ONE of the following gasses is a colourless oxidising agent and a component of all combustion processes?

A CO_2
B NH_3
C O_2
D CH_4

(5 × 3) **[15]**

TOTAL SECTION A: 35

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SECTION B

QUESTION 5

5.1 Define each of the following terms:

5.1.1 Compression stress

5.1.2 Shear stress

(2 × 2) (4)

5.2 The following questions are based on H_2S and H_2O molecules.

5.2.1 How many valence electrons does the sulphur atom have? (1)

5.2.2 What is the valency of the oxygen atom? (1)

5.2.3 Draw the Lewis diagram of each of the following molecules:

(a) H_2S

(b) H_2O

(2 × 2) (4)

5.2.4 What is the shape of the H_2O molecule? (1)

5.2.5 Which molecule, H_2S or H_2O, does not obey the octet rule? (1)

5.2.6 Give a reason for the answer to QUESTION 5.2.5. (1)

5.2.7 Name the type of intramolecular bond in the H_2S molecule? (1)

5.2.8 Explain why the H_2O molecule is polar. (4)

5.2.9 Name the intermolecular force that exists between H_2O molecules. (1)

5.3 A student investigated the relationship between load (force) and the extension of a rubber band. She tabulated the following results:

Force in N	Length of rubber band in cm
0	5,3
1,5	8,9
3,0	12,7

5.3.1 State Hooke's law. (2)

5.3.2 Does the rubber band obey Hooke's law? Substantiate the answer with appropriate calculations. (3)

[24]

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QUESTION 6

6.1 Construction engineers wish to build a 500 m long bridge using concrete. One of the team members advised the other engineers to consider linear expansion of the concrete as South African temperatures may vary by as much as 20 °C between summer and winter.

6.1.1 What will happen to the solid concrete when exposed to significant temperature changes? (2)

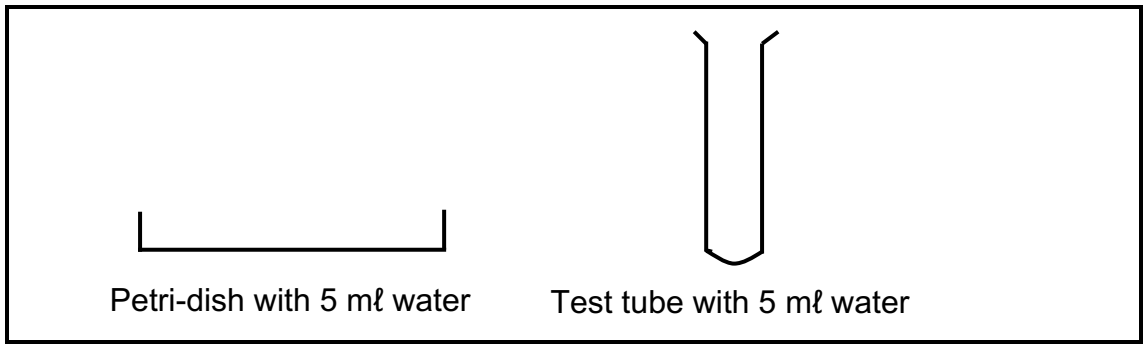
6.1.2 If the linear expansion coefficient of concrete is $1,24 \times 10^{-5}$ per °C, calculate the change in length in cm when the temperature of the 500 m long bridge increases from 19 °C (in winter) to 39 °C (in summer). (5)

6.2 An international oil company handles crude oil between west Africa and east Asia. They find that the oil flows at different rates through their pipelines between these two different climate zones.

6.2.1 What is *viscosity*? (2)

6.2.2 Give THREE reasons why the oil from these two different sources flow at different rates. (3)

6.3 A group of L3 learners were investigating the factors affecting evaporation. They poured 5 mℓ of water into a petri-dish and a test tube respectively and left the apparatus overnight. The next morning they observed that there was no water in the petri-dish whilst the test tube had water in it. By measurement, they noted that the volume of water in the test tube had reduced.



6.3.1 What is *evaporation*? (2)

6.3.2 Write an investigative question for this experiment. (2)

6.3.3 Give the following for the experiment:

(a) Independent variable

(b) Dependent variable

(c) Controlled variable

(3 × 1) (3)

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6.4 An unknown amount of nitrogen gas is sealed in a container with a volume of 4,2 dm^3 at a temperature of 60 °C and a pressure of 150 kPa.

6.4.1 Calculate the number of moles of nitrogen gas present in the container. (4)

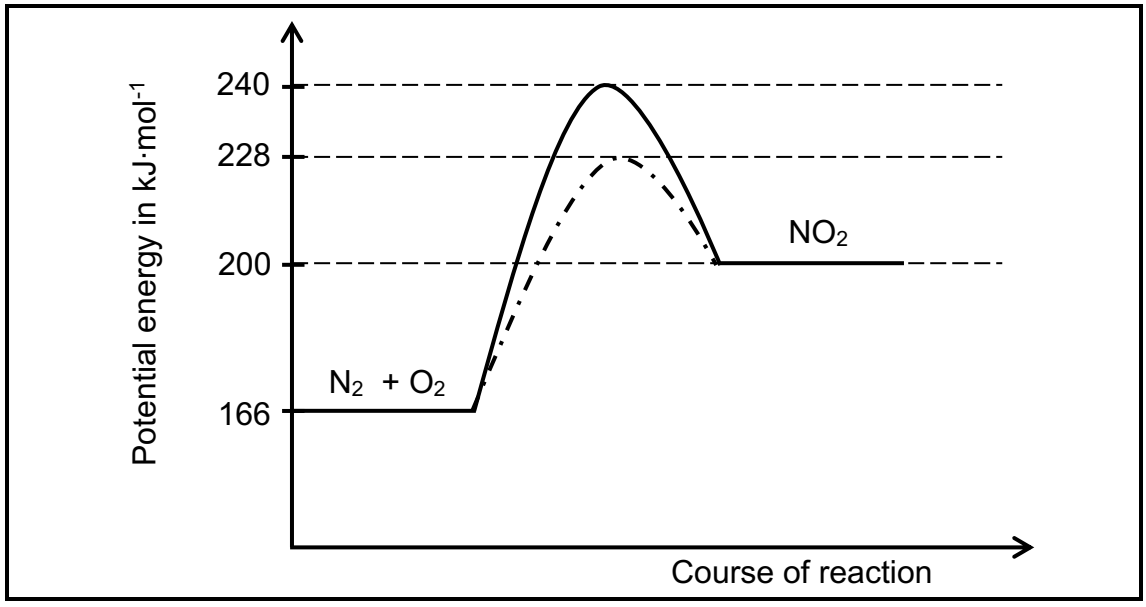
6.4.2 Calculate the mass of nitrogen gas present in the container. (3)

6.5 It has been observed that liquids generally expand more than solids when heated.

Explain this observation. (3)
[29]

QUESTION 7

7.1 The diagram below illustrates the potential energy changes during the course of a reversible chemical reaction. The diagram is not drawn to scale.



7.1.1 Give the formulae for each of the following in the forward reaction:

(a) Reactants

(b) Products

(2 × 2) (4)

7.1.2 Write a balanced chemical equation for the reverse reaction. (3)

7.1.3 Is the forward reaction exothermic or endothermic? (1)

7.1.4 Give ONE reason for the answer to QUESTION 7.1.3. (2)

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7.1.5 From the diagram calculate:

(a) ΔH for the forward reaction

(b) The activation energy for the uncatalysed forward reaction

(c) The decrease in the activation for the reaction by the addition of a catalyst

(3 × 2) (6)

7.2 Propane gas (C_3H_8) is one of the alkanes which readily burns in oxygen to form carbon dioxide (CO_2) and water (H_2O). The following chemical equation represents the process:

$$C_3H_8(g) + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

7.2.1 Calculate the volume of propane gas (C_3H_8) that was burned in excess oxygen to produce 60 cm^3 of carbon dioxide (CO_2) at STP. (5)

7.2.2 Show that mass is conserved in this reaction. (5)
[26]

QUESTION 8

8.1 Ammonia is produced in the Haber process by reacting nitrogen with hydrogen according to the following equation:

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

50 cm^3 of N_2 is allowed to react with 120 cm^3 of H_2 without any changes in temperature and pressure.

8.1.1 Determine which substance is in excess and by how much. (4)

8.1.2 Calculate the volume of NH_3 produced. (2)

8.1.3 Determine the number of molecules of NH_3 produced. (4)

8.2 Pieces of clean magnesium metal are added to each of the following aqueous solutions:

A Lead sulphate ($PbSO_4$)
B Calcium chloride ($CaC\ell_2$)
C Potassium nitrate (KNO_3)
D Copper chloride ($CuC\ell_2$)
E Iron sulphate ($FeSO_4$)

The reactivity of metals from most reactive to least reactive is as follows:

K, Ca, Mg, Fe, Pb, Cu

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8.2.1 In which solutions will a reaction take place? Write only the letters (A–E) next to the question number (8.2.1) in the ANSWER BOOK. (3)

8.2.2 Write a balanced equation for the reaction between Ca and $Pb(NO_3)_2$. (2)

8.3 Balance each of the following chemical equations and indicate whether it is a decomposition, combination or displacement reaction:

8.3.1 $NaC\ell O_3$ + heat → $NaC\ell$ + O_2

8.3.2 Mg (s) + $Fe_2(SO_4)_3$ → $MgSO_4$ + Fe

8.3.3 NO_2 + H_2O (l) + O_2 → HNO_3

(3 × 3) (9)

8.4 Write down the formula of the product(s) in each of the following reactions:

8.4.1 Na + H_2O →

8.4.2 Zn + $HC\ell$ →

(2 × 2) (4)
[28]

QUESTION 9

9.1 Give TWO uses of each of the following:

9.1.1 Oxygen gas

9.1.2 Methane gas

9.1.3 Ammonia gas

(3 × 2) (6)

9.2 What is meant by *air pollution*? (2)
[8]

TOTAL SECTION B: 115
GRAND TOTAL: 150

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INFORMATION SHEET

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Avogadro's constant	N_A	$6{,}02 \times 10^{23}$ mol^{-1}
Molar gas volume at STP	V_m	22,4 dm^3.mol^{-1}
Standard pressure	$p^{\emptyset}$	$1{,}013 \times 10^5$ Pa
Standard temperature	$T^{\emptyset}$	273 K
Charge on electron	e	$-1{,}6 \times 10^{-19}$ C
Molar gas constant	R	8,31 J.K^{-1}.mol^{-1}

TABLE 2: FORMULAE

$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$	$pV = nRT$
$n = \frac{m}{M}$	$c = \frac{n}{V}$
$c = \frac{m}{MV}$	$\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b}$

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THE PERIODIC TABLE OF ELEMENTS
DIE PERIODIEKE TABEL VAN ELEMENTE

