higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE
(Second Paper)
NQF LEVEL 3

(10021003)

26 November 2019 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 11 pages, 1 information sheet and 1 periodic table.

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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. Approximate ALL final answers to TWO decimal places.
6. Use the attached DATA SHEET and PERIODIC TABLE.
7. Show ALL formulae and substitutions in ALL calculations.
8. Start each section on a NEW page.
9. Use only a BLUE or BLACK pen.
10. Write neatly and legibly.

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SECTION A

QUESTION 1

Give ONE word or term for each of the following descriptions. Write only the word or term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 The ability of a substance to recover its original shape and size after distortion.

1.2 The collective name for elements with seven valence electrons.

1.3 A reaction that has a positive change in enthalpy.

1.4 The non-polar product of the complete combustion of organic compounds.

1.5 The shape of a methane molecule.

(5 × 1) **[5]**

QUESTION 2

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

COLUMN A		COLUMN B	
2.1	Most abundant inert gas found in the atmosphere	A	low vapour pressure
2.2	Potential energy of the products is less than the potential energy of the reactants	B	oxygen
2.3	Occurs when bonding electrons are shared unequally	C	covalent bonding
2.4	Responsible for liquefaction of gases	D	intermolecular force
2.5	Volatile liquids	E	nitrogen
		F	intramolecular force
		G	high vapour pressure
		H	exothermic reaction
		I	polar covalent bond
		J	endothermic reaction

(5 × 1) **[5]**

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QUESTION 3

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

3.1 The rate of evaporation is increased by decreasing the surface area of the liquid.

3.2 Smog consists of small water droplets that form when warm air containing water vapour is suddenly cooled.

3.3 Water has two non-bonding electron pairs.

3.4 Enclosed gases exert pressure on the containers because the molecules in a gas are continuously moving and they collide against the sides of the container.

3.5 The minimum amount of energy needed for a reaction to occur is called the heat of reaction.

(5 × 2) **[10]**

QUESTION 4

Various options are given 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 Which ONE of the following balanced equations represents a reaction in which electrons are transferred?

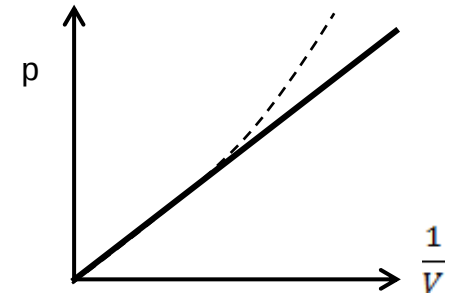
A $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$
B $Mg(s) + HC\ell\,(aq) \rightarrow H_2(g) + MgC\ell_2\,(aq)$
C $2NaC\ell(aq) + Pb(NO_3)_2(aq) \rightarrow 2NaNO_3(aq) + PbC\ell_2(s)$
D $H_2SO_4(aq) + Ba(NO_3)_2(aq) \rightarrow BaSO_4(s) + 2HNO_3(aq)$

4.2 Which ONE of the following pairs has the same electron arrangement as an aluminium ion?

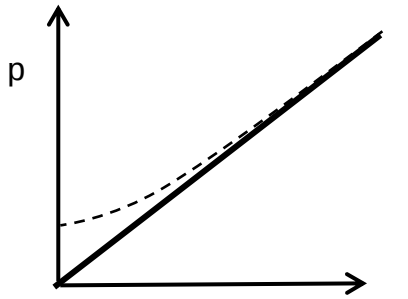
A O^{2-} and K^+
B Na^+ and $C\ell^-$
C Ca^{2+} and S^{2-}
D Mg^{2+} and F^-

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

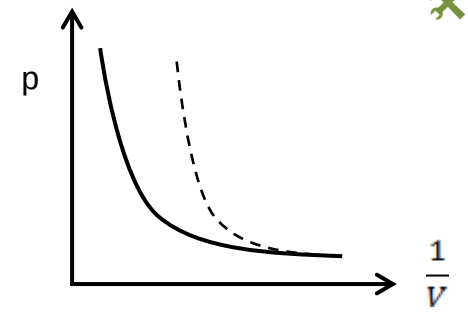
A



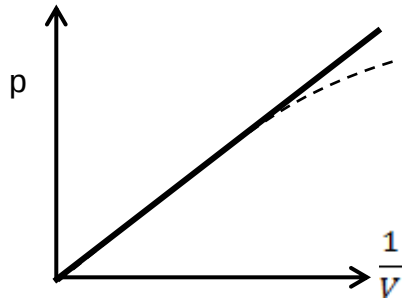
B



C



D



4.4 A total of 12 moles of hydrogen gas (H_2) and 4,5 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 3 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	7,5	3,0
B	4,5	3,0
C	4,5	1,5
D	7,5	1,5

4.5 During the displacement reaction between potassium iodide and chlorine, xylene was added to the mixture. The xylene turned purple because of the …

A iodide ions.
B chloride ions.
C iodine molecules.
D chlorine molecules.

(5 × 3) **[15]**

TOTAL SECTION A: 35

SECTION B

QUESTION 5

5.1 What is the difference between an *elastic material* and a *plastic material*? (2)

5.2 A spanner that was used to tighten bolts suddenly breaks off while in use.

5.2.1 Is this because the spanner is too brittle or too ductile?

5.2.2 What type of fracture would you expect to find at the point where the spanner broke?

(2 × 2) (4)

5.3 Complete the following sentences by filling in the missing word or words. Write only the word or words next to the question number (5.3.1–5.3.2) in the ANSWER BOOK.

5.3.1 … stress is experienced when a metal is pushed by perpendicular forces.

5.3.2 … stress is experienced when a metal is pulled by perpendicular forces.

(2 × 1) (2)

5.4 Solids occur in different crystalline forms.

Na(s); C(s); I_2(s); NaF(s); H_2O(s)

From the list, select a compound that fits the description:

5.4.1 Conducts electricity in solid and molten states.

5.4.2 The crystal lattice consists of cations and anions.

5.4.3 Changes directly from a solid into a gas.

(3 × 2) (6)

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5.5 The ammonia molecule (NH_3) is pyramidal in shape.

5.5.1 Draw the Lewis structure for NH_3. (2)

5.5.2 Is the N-–H bond in NH_3 polar or non-polar? (1)

5.5.3 Give a reason for the answer to QUESTION 5.5.2. (2)

5.5.4 Is the NH_3 molecule polar or non-polar? (1)

5.5.5 Give a reason for the answer to QUESTION 5.5.4. (2)

[22]

QUESTION 6

6.1 State TWO properties of gases, as described by the Kinetic Molecular Theory. (2)

6.2 A balloon containing 250 cm^3 amount of nitrogen gas enclosed in it at 25 °C and 100 kPa is immersed in hot water at 55 °C. The volume of the balloon increases to 1 500 cm^3. Assume that the gas temperature increased.

6.2.1 Using the Kinetic Molecular Theory, explain why the volume of the balloon increased when the enclosed gas temperature increased? (3)

6.2.2 Calculate the pressure of the enclosed nitrogen gas at 55 °C. (4)

6.3 A total of 23 g of a molecular gas occupies 2 000 cm^3 at a pressure of 900 kPa and a temperature of 30 °C.

6.3.1 Calculate the number of moles of this gas. (4)

6.3.2 What is the molar mass of this gas? (3)

6.3.3 Identify this gas. (1)

[17]

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QUESTION 7

7.1 Explain each of the following terms:

7.1.1 Evaporation

7.1.2 Vapour pressure

(2 × 2) (4)

7.2 The Kinetic Molecular Theory of Matter can be used to explain what happens to particles in substances when they are subjected to temperature changes.

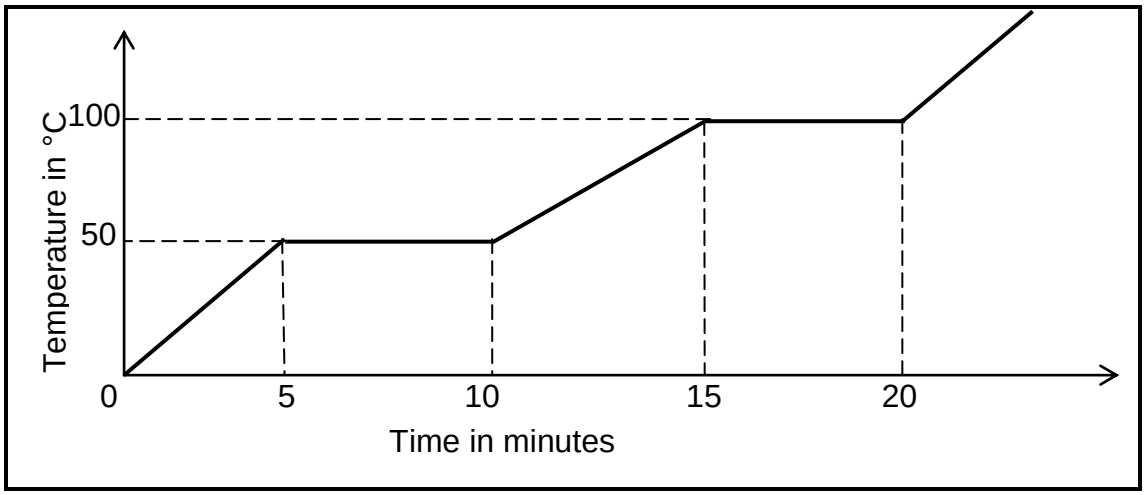
Use the Kinetic Molecular Theory to give reasons for the following:

7.2.1 During the night, a tin roof (made of corrugated iron sheets) creaks after a warm day.

7.2.2 Concrete roads are laid in sections with pitch between them.

(2 × 2) (4)

7.3 The graph below shows the change in temperature of a substance as it is heated at constant pressure.



7.3.1 What is the phase of the substance at 12 minutes?

7.3.2 Why is there no temperature change between the 5th and 10th minute?

7.3.3 At what temperature will this substance change from a liquid to a solid?

7.3.4 What happens to the substance between the 10th and 15th minute?

(4 × 2) (8)

[16]

QUESTION 8

8.1 In an experiment, a group of learners reacted vinegar (CH_3COOH) with baking soda ($NaHCO_3$) and noticed that the temperature of the system increased as the reaction progressed.

The equation for the reaction taking place is :

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2 + H_2O$$

8.1.1 Is the reaction exothermic or endothermic? Give a reason for the answer. (2)

8.1.2 Draw a fully labeled graph of potential energy against the reaction coordinate. Assume that the reactants have zero potential energy.

On your graph, indicate:
- Labels on the axes
- Potential energy of the products
- Activation energy for the forward reaction
- ΔH for the forward reaction (6)

8.2 When 8 g of an impure sample of potassium chlorate ($KC\ell O_3$) is heated, 1 800 cm^3 of oxygen is produced.

The chemical equation for this reaction is :

$$2\ KC\ell O_3 \longrightarrow 2\ KC\ell + 3\ O_2$$

Take the molar volume to be 24 dm^3 at this high temperature.

NOTE: ALL calculations must be correct to FOUR decimals.

8.2.1 What type of a reaction is this? (2)

8.2.2 Show that mass is conserved in this chemical reaction. (5)

8.2.3 Calculate the number of moles of oxygen that is produced. (4)

8.2.4 Determine the mass of pure potassium chlorate in the sample. (4)

8.2.5 Calculate the percentage purity of the sample of potassium chlorate. (2)

[25]

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QUESTION 9

9.1 Rewrite and balance each of the following chemical equations in the ANSWER BOOK.

9.1.1 $P_4 + O_2 \rightarrow P_2O_5$

9.1.2 $SiC\ell_4 + H_2O \rightarrow H_4SiO_4 + HC\ell$

9.1.3 $A\ell + FeO \rightarrow A\ell_2O_3 + Fe$

(3 × 2) (6)

9.2 Complete the chemical equations by writing the CHEMICAL FORMULA of the product(s) formed in your ANSWER BOOK.

9.2.1 calcium + oxygen →

9.2.2 sodium + water →

9.2.3 sulphur dioxide + water →

(3 × 2) (6)

9.3 A total of 4,25 g silver nitrate ($AgNO_3$) was dissolved in sufficient water and placed in a large beaker with 0,015 mol of magnesium chloride solution ($MgC\ell_2$).

The chemicals reacted according to the following balanced chemical equation:

$2\ AgNO_3 + MgC\ell_2 \rightarrow 2\ AgC\ell_{(s)} + Mg(NO_3)_2$

NOTE: ALL calculations must be correct to FOUR decimals.

9.3.1 What type of reaction is this? (2)

9.3.2 Calculate the molar mass of silver nitrate. (2)

9.3.3 How many moles of silver nitrate were dissolved in water? (3)

9.3.4 Determine which ONE of the reactants is in excess and by how much. (4)

9.3.5 Calculate the mass of silver chloride ($AgC\ell_{(s)}$) that is produced. (4)

[27]

QUESTION 10

10.1 Define each of the following terms:

10.1.1 Hazardous gases

10.1.2 Pollutants

(2 × 2) (4)

10.2 Write the question number (10.2.1–10.2.4) in the ANSWER BOOK.

Complete the table by writing the chemical formula/name of gas/industrial use of gas next to the corresponding number.

CHEMICAL FORMULA OF GAS	NAME OF GAS	INDUSTRIAL USE OF GAS
O_2	Oxygen gas	10.2.1
10.2.2	Methane gas	Cooking or heating
CO_2	Carbon dioxide	10.2.3
N_2	Nitrogen gas	Excellent coolant
NH_3	Ammonia gas	10.2.4

(4)
[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^θ	$1{,}013 \times 10^5$ Pa
Standard temperature	T^θ	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

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$	pV = nRT
$n = \frac{m}{M}$	$c = \frac{n}{V}$
$c = \frac{m}{MV}$	$\frac{n_a}{n_b} = \frac{c_aV_a}{c_bV_b}$

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THE PERIODIC TABLE OF ELEMENTS
DIE PERIODIEKE TABEL VAN ELEMENTE

