higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE
(Second paper)
NQF LEVEL 3

(10021003)

12 March 2020 (X-paper)
09:00–12:00

This question paper consists of 10 pages, 1 sheet of graph paper, 1 periodic table and 1 data sheet.

549Q1S2012

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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. Approximate all final answers to two decimal places.
5. Show the formulae and substitutions in all the calculations.
6. Answer QUESTION 6.2.3 on the graph paper (attached). Write your examination number and the centre number on the graph paper, detach it from the question paper and hand it in with the ANSWER BOOK.
7. Start each section on a new page.
8. Use only a black or blue pen.
9. Write neatly and legibly.

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SECTION A

QUESTION 1

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

1.1 The deformation of an elastic material is directly proportional to the force applied to it

1.2 The minimum energy that reactants must have in order to form products

1.3 A layer of allotropic oxygen that protects the earth from harmful UV radiation

1.4 The volume of an enclosed gas is directly proportional to its absolute temperature at constant pressure

1.5 The quantity of matter which contains Avogadro's number of fundamental particles

(5 × 1) **[5]**

QUESTION 2

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

COLUMN A		COLUMN B	
2.1	Energy stored in chemical bonds	A	CO
2.2	Energy required for a phase change	B	condensation
2.3	Pressure exerted by the atmosphere at sea level	C	101,3 kPa
		D	4
2.4	Combines with haemoglobin to reduce oxygen uptake	E	potential energy
2.5	Oxidation state of carbon in H_2CO_3	F	273 kPa
		G	CO_2
		H	activation energy
		I	latent heat
		J	2

(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 It is very cold when snow falls because the latent heat of fusion is absorbed from the atmosphere.

3.2 Sulphur dioxide emitted from industries reacts with water vapour in the atmosphere to produce sulphurous acid.

3.3 A material is malleable if it can be bent and hammered into shape.

3.4 A reaction in which a compound breaks down into two or more substances is called a displacement reaction.

3.5 Bromine water will react with potassium iodide and not with potassium chloride.

(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 gases irritates the mucous membrane lining of the respiratory tract and causes asthma?

A CO
B NO_2
C CO_2
D SO_2

4.2 Which ONE of the following substances has the strongest intermolecular forces?

A HF
B HI
C HCℓ
D HBr

4.3 What type of stress results from a material being pushed or pulled by perpendicular forces?

A Shear
B Elastic
C Pushing
D Compression

4.4 10 cm^3 of hydrogen and 10 cm^3 of oxygen are allowed to react at STP according to the following chemical equation:

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$$

What will be the volume of the gases at the end of the reaction if there is no change in temperature and pressure?

A 5 cm^3
B 10 cm^3
C 15 cm^3
D 20 cm^3

4.5 The volume of a gas at a certain temperature and pressure is V.

If the temperature is halved and the pressure is doubled then the volume of the gas will be ...

A ½ V.
B ¼ V.
C 2 V.
D 4 V.

(5 × 3) **[15]**

TOTAL SECTION A: 35

SECTION B

QUESTION 5

5.1 When materials are subjected to stress, they may change their dimensions.

Define the following terms:

5.1.1 Stress

5.1.2 Strain

(2 × 2) (4)

5.2 State the mechanical property of a material that leads to the following:

5.2.1 Materials that break with little or no deformation

5.2.2 Materials that resist bending i.e. they do not bend easily

5.2.3 Materials that can be bent and hammered into shape

5.2.4 Materials that can be drawn into wires without breaking

(4 × 1) (4)

5.3 The table below indicates the boiling points of the group 5 hydrides.

	Hydride	Boiling point in °C
A	NH_3	- 33,3
B	PH_3	- 87,7
C	SbH_3	- 18,4
D	AsH_3	- 62,4

5.3.1 Which ONE of the hydrides has the highest boiling point? (2)

5.3.2 Give an explanation for the answer to QUESTION 5.3.1 in terms of intermolecular forces and energy. (3)

5.3.3 Arrange the hydrides B, C and D in order of increasing boiling point. (2)

5.3.4 Identify the factor responsible for the variation in boiling points in QUESTION 5.3.3. (2)

[17]

QUESTION 6

6.1 An ideal gas obeys all the gas laws under all conditions of temperature and pressure.

State THREE properties of an ideal gas. (3)

6.2 A researcher investigated the relationship between the volume of an enclosed gas and its temperature.

She tabulated the following results:

Volume in cm^3	Temperature in kelvin (K)
33	50
98	150
163	250
230	350

6.2.1 Write an investigative question for this investigation. (2)

6.2.2 State ONE variable that must be kept constant. (2)

6.2.3 Plot a graph of volume versus temperature in kelvin on the graph paper (attached).

Write your examination number and the centre number on the graph paper, detach it from the question paper and hand it in with the ANSWER BOOK. (4)

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6.2.4 State a conclusion that can be made from the graph. (2)

6.2.5 Why does a real gas deviate from the ideal gas behaviour at low temperatures? (2)

6.3 Show by calculation that the volume of one mole of nitrogen gas is 22,4 dm^3 at STP. (4)

[19]

QUESTION 7

7.1 The movement of molecules in different parts of a liquid are restricted by friction. Water and oil have different viscosities.

7.1.1 What is *viscosity*? (2)

7.1.2 Which one has a higher viscosity, water or oil? (1)

7.1.3 Give a reason for the answer to QUESTION 7.1.2. (2)

7.1.4 State the relationship between *viscosity* and *temperature*. (2)

7.2 Water has a standard boiling point of 100 °C. At this temperature water changes from a liquid into steam.

Define the following terms:

7.2.1 Boiling point

7.2.2 Latent heat of vaporisation

(2 × 2) (4)

7.3 A 60 g cube of ice is taken from a freezer at -10 °C and dropped into a glass of water at 0 °C. If no heat is gained or lost from the outside, how much ice will freeze onto the cube?

HINT:
Specific heat capacity of water = 4 200 $J \cdot kg^{-1} \cdot {}^{\circ}c^{-1}$
Specific heat capacity of ice = 2 100 $J \cdot kg^{-1} \cdot {}^{\circ}c^{-1}$
Latent heat of fusion of water = 333 000 $J \cdot kg^{-1}$ (6)

7.4 Water boils at a temperature of 100 °C at sea level.

7.4.1 Will the boiling point of water 'Increase', 'Decrease' or 'Remain the same' on a mountain top? (1)

7.4.2 Give a reason for the answer to QUESTION 7.4.1. (2)

[20]

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QUESTION 8

8.1 Write down and balance the following chemical equations:

8.1.1 $S_8 + O_2 \rightarrow SO_3$

8.1.2 $Fe + H_2O \rightarrow Fe_3O_4 + H_2$

(2 × 2) (4)

8.2 The following chemical reactions are performed in a laboratory:

P	$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
Q	$2H_2O_2 \rightarrow 2H_2O + O_2$
R	$H_2SO_4 + NaOH \rightarrow Na_2SO_4 + H_2O$
T	$2Na + O_2 \rightarrow 2NaO$

Which one of the chemical reactions in the table represents the following:

8.2.1 Decomposition reaction

8.2.2 Combination reaction

(2 × 2) (4)

8.3 Hydrogen reacts with oxygen to form water according to the following chemical equation:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Covalent bond	Bond energy in kJ·mol^{-1}
H — H	436
O — O	146
O = O	498
O — H	463

8.3.1 What is *bond energy*? (2)

8.3.2 Calculate the energy intake when water is formed. (3)

8.3.3 Calculate the energy given off when water is formed. (3)

8.3.4 Determine ΔH for the reaction. (2)

8.4 Define the following terms:

8.4.1 Catalyst

8.4.2 Endothermic reaction

(2 × 2) (4)

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8.5 Calculate the energy produced if 0,4 mol CO is formed according to the following chemical equation:



$$2C + O_2 \rightarrow 2CO + 441\ kJ$$ (3)

[25]

QUESTION 9

9.1 Mercury is the only metal that exists as a liquid at room temperature. It can be obtained by heating mercury (ii) oxide according to the following chemical equation:

$$2\ HgO \longrightarrow 2\ Hg + O_2$$

NOTE: All calculations must be correct to THREE decimal places.

9.1.1 Use relevant calculations to show that mass is conserved in a chemical reaction. (4)

9.1.2 If 10,85 g HgO is heated, calculate:

(a) The maximum mass of Hg that will be produced  (3)

(b) The maximum volume of O_2 that will be produced if the molar volume is assumed to be 24 dm^3 at a high temperature (5)

9.2 Write the chemical formula of the product for each of the following incomplete chemical equations:

9.2.1 $Na + O_2 \rightarrow$

9.2.2 $CaO + H_2O \rightarrow$

9.2.3 $C\ell_2 + NaBr \rightarrow$  (3 × 2) (6)

9.3 When zinc was placed in a solution of copper(II) sulphate, the solution changed from blue to colourless and a brown solid was formed.

9.3.1 Write the formula of the ion responsible for the blue colour. (1)

9.3.2 What type of reaction occurred between copper(II) sulphate and zinc?  (2)

9.3.3 Write a balanced chemical equation for the reaction. (4)

[25]

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QUESTION 10

10.1 Define the following terms with regard to industrial gases:

10.1.1 Air pollution

10.1.2 Greenhouse effect

(2 × 2) (4)

10.2 Choose a substance from the following list that matches each of the descriptions below:

N_2; O_2; CH_4; NH_3; CO_2; H_2; SO_2

10.2.1 Used as a source of fuel in gas cookers

10.2.2 Highly flammable gas used as a reactant in the industrial production of ammonia

10.2.3 An oxidising agent and component of all combustion processes

10.2.4 Used in the manufacture of explosives and fertilisers

10.2.5 High density gas used to extinguish electrical fires

(5 × 1) (5)
[9]

TOTAL SECTION B: 115
GRAND TOTAL: 150

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DATA 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}

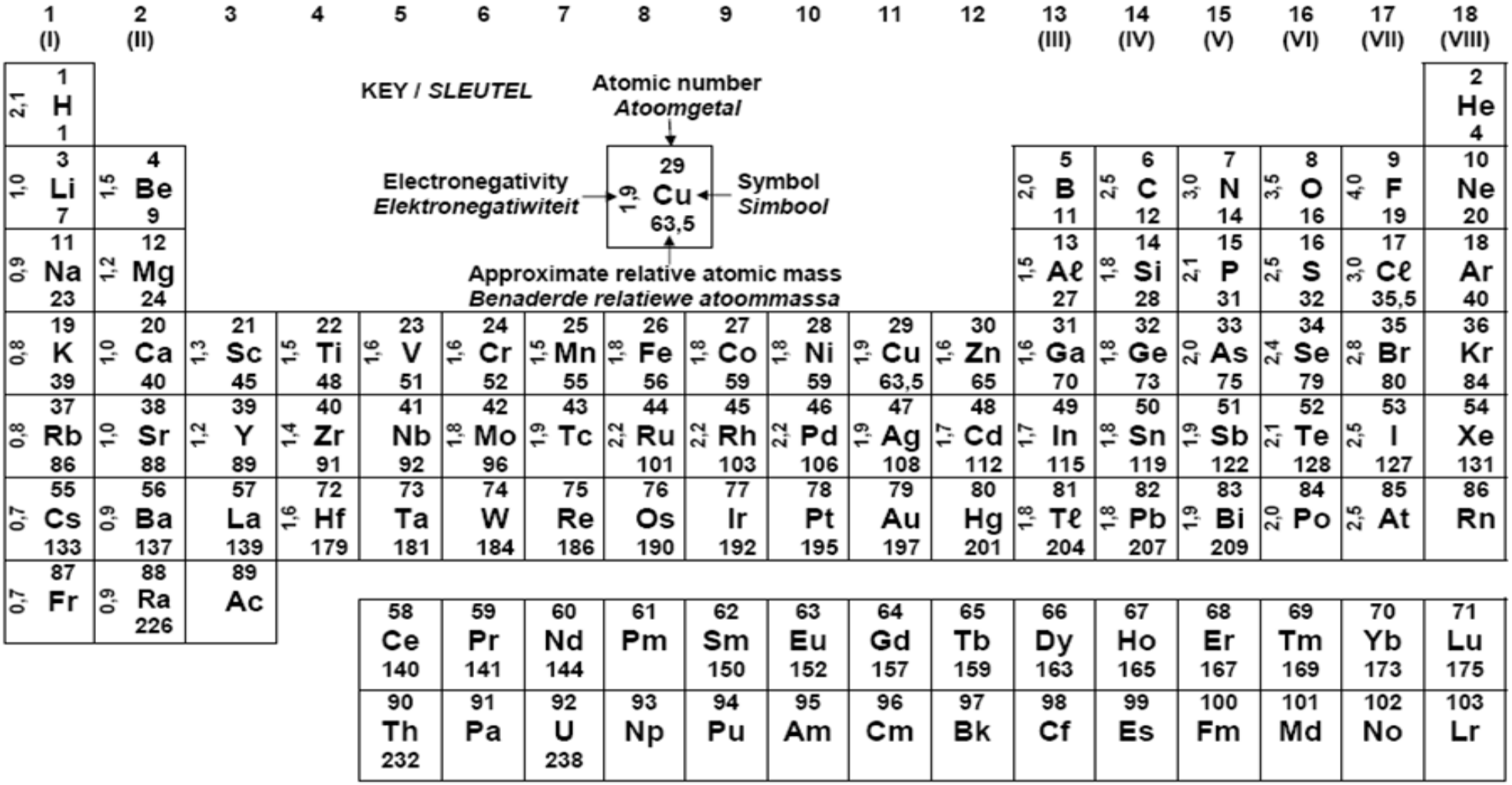
TABLE 2: FORMULAE

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

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THE PERIODIC TABLE OF ELEMENTS
DIE PERIODIEKE TABEL VAN ELEMENTE



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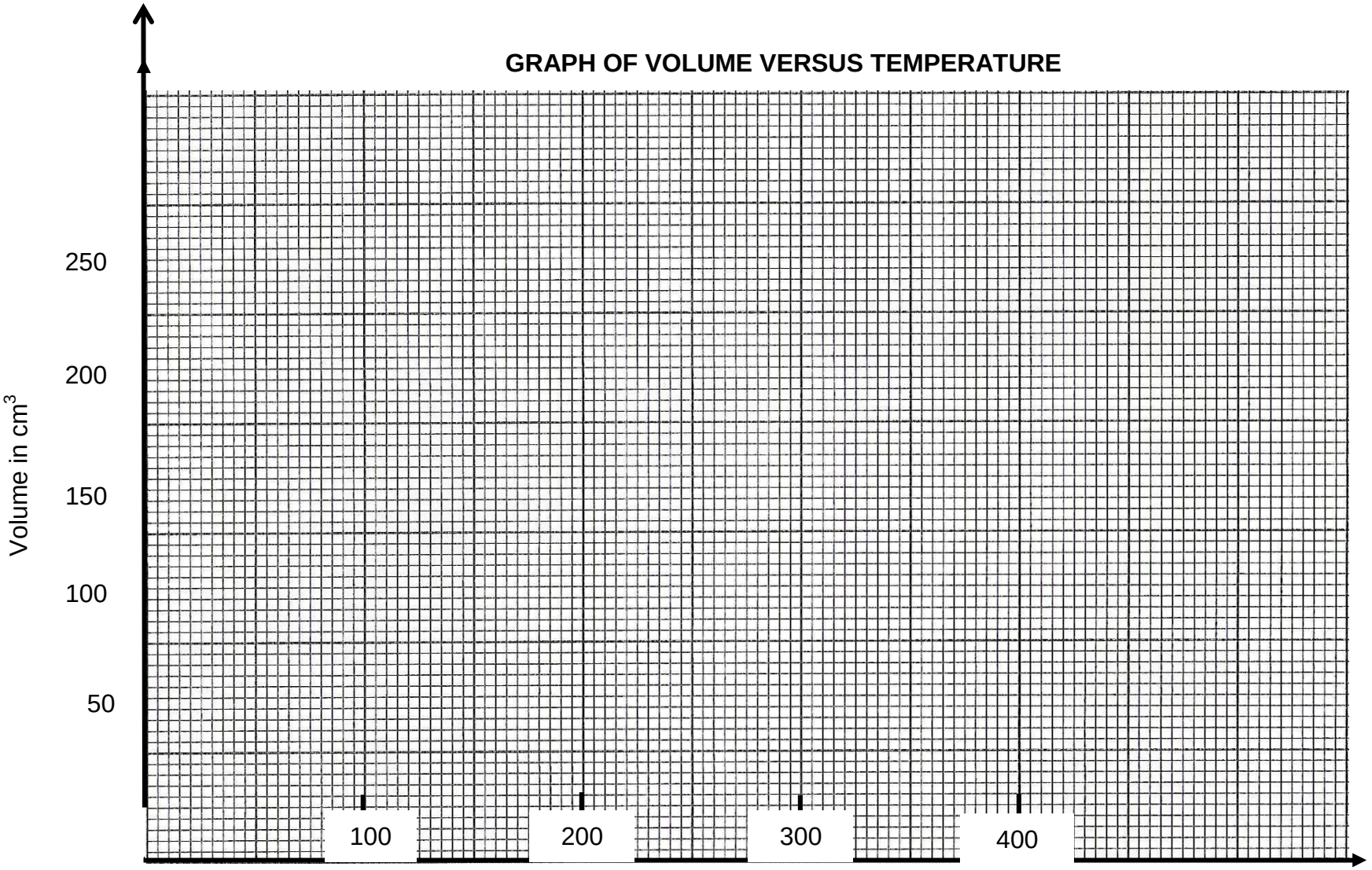
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QUESTION 6.2.3

EXAMINATION NUMBER: _____

CENTRE NUMBER: _____

GRAPH OF VOLUME VERSUS TEMPERATURE



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