GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PROVINCIAL EXAMINATION

JUNE 2022

GRADE 11

PHYSICAL SCIENCES
(PHYSICS AND CHEMISTRY)

TIME: 2 hours

MARKS: 100

10 pages, 3 data pages and 1 formula page

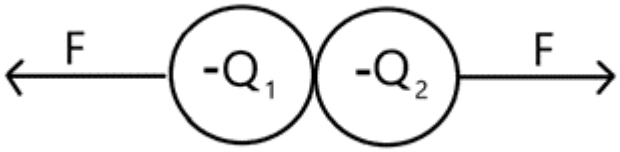
INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of FIVE 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 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 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, for example 1.11 A.

1.1 Two small identical objects, each with a net charge of -Q, are placed next to each other in a vacuum tube. They move apart.



Which of the following statements is CORRECT?
The electrostatic force will ...

A decrease at a constant rate.
B decrease exponentially.
C stay the same.
D increase at a constant rate. (2)

1.2 Two identical point charges A and B, having charges of –3pC and +9pC respectively, are allowed to touch and then moved apart. The charge in pC on each sphere is now ...

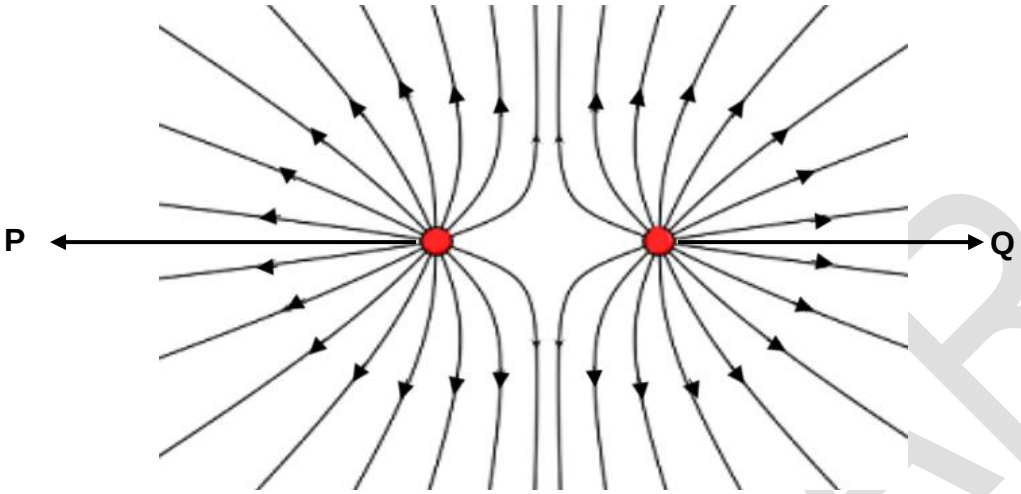
	A	B
A	+3	–9
B	+3	+3
C	–3	–3
D	0	0

(2)

1.3 An electric field strength created by charge Q is measured to be 40 $N{\cdot}C^{-1}$ at a distance of 0,2 m from the center of the charge. What is the new field strength when the distance from the center of Q is changed to 0,4 m away with twice the charge of Q?

A 3 200 $N{\cdot}C^{-1}$
B 1 600 $N{\cdot}C^{-1}$
C 800 $N{\cdot}C^{-1}$
D 20 $N{\cdot}C^{-1}$ (2)

1.4 P and Q are two electrostatically charged bodies. If the electric field pattern between them is as shown below, then …



A P and Q are both negative.
B P and Q are both positive.
C P is negative and Q is positive.
D P is positive and Q is negative. (2)

1.5 The type of intermolecular force involved when CO_2 is added to water vapour is:

A Ion-induced dipole forces
B Dipole-dipole forces
C London forces
D Dipole-induced dipole forces (2)

1.6 Refer to the list of substances below.

HCl, Cl_2, H_2O, NH_3, N_2, HF

Select the TRUE statement from the list below.

A NH_3 is a non-polar molecule.
B Ion-dipole forces exist between molecules of HF.
C The melting point of NH_3 will be higher than for Cl_2.
D At room temperature N_2 is usually a liquid. (2)

1.7 Balance the following equation using minimum integral coefficients:

$$NH_3 + O_2 \rightarrow NO_2 + H_2O$$

The stoichiometric coefficient for oxygen gas (O_2) is:

A 1
B 4
C 3
D 7 (2)

1.8 Two moles of H_2 gas at STP occupy a volume of:

A 44,8 dm^3
B 22,4 dm^3
C 11,2 dm^3
D 2 dm^3 (2)

1.9 Which of the following statements is TRUE?

I. The molar mass of $CaCO_3$ is 100 $g \cdot mol^{-1}$.
II. 50 g of $CaCO_3$ contains 9×10^{23} oxygen atoms.
III. A 200 g sample of $CaCO_3$ contains 2 moles of $CaCO_3$.

A I only
B II only
C III only
D I, II, and III (2)

1.10 1,50 mol of SO_2 and 1 mol of O_2 are sealed in a 1 dm^3 flask and allowed to react completely at STP according to the following balanced equation:

$$2\ SO_2\ (g) + O_2\ (g) \rightarrow 2\ SO_3\ (g)$$

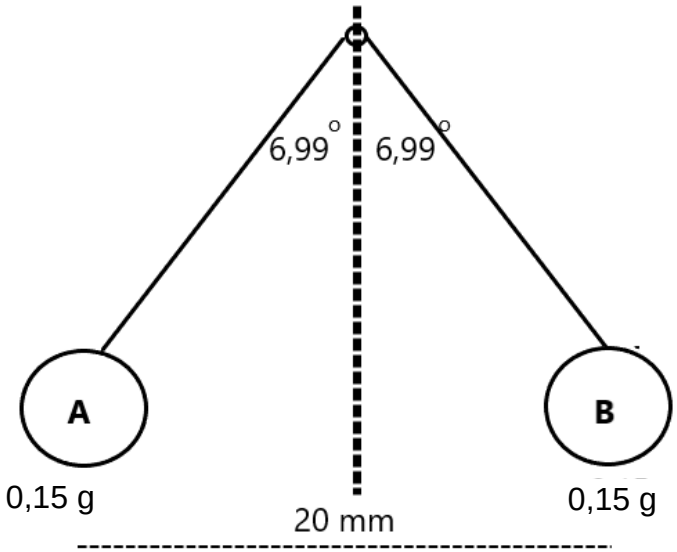
The total number of moles of gas in the flask at the end of the reaction is:

A 2
B 1,75
C 0,75
D 0,25 (2)

[20]

QUESTION 2 (Start on a new page.)

Two identical negatively charged spheres, **A** and **B**, both with a mass 0,15 g, hang from the same point by thin, inextensible strings (mass of the strings can be ignored). The electrostatic force between the spheres causes them to move 20 mm apart. The angle between one of the silk threads and the vertical is 6,99°.



2.1 Define *Coulomb's law* in words. (2)

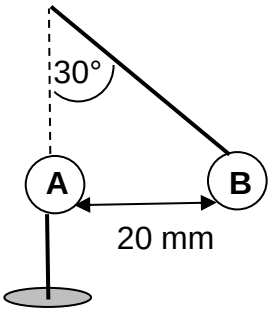
2.2 Draw a free body diagram of all the forces acting on sphere **A**. (3)

2.3 Use your answer to QUESTION 2.2 to calculate the magnitude of the force to the left on **A**. (4)

2.4 State Newtons third law of motion in words. (2)

2.5 Calculate the charge on both Q_A and Q_B. (4)

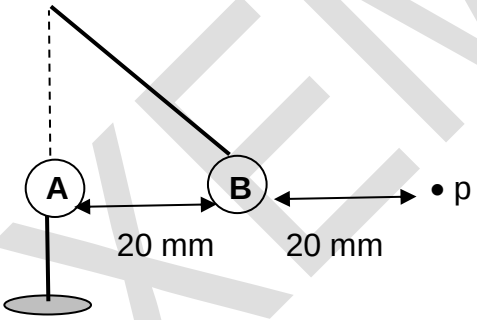
2.6 In a different scenario, **A** and **B** are two identical, negatively charged small spheres with a mass of 5 g. **A** is mounted on an insulated stand and **B** hangs from a light silk thread. The system is in equilibrium. **B** hangs 30° to the vertical as shown in the diagram below, **A** and **B** are 20 mm apart in the same horizontal plane.



Define *electric field strength at a point* in words. (2)

2.7 Draw the electric field pattern between two charged spheres **A** and **B**. (3)

2.8 A small test charge is placed 20 mm to the right of sphere **B**, on the same plane. If the charges on both **A** and **B** is -3,58 nC and the repulsive force of sphere **A** on sphere **B** is 0,028 N to the right:



Calculate the net electrostatic field on • **p**, due to charges **A** and **B**. (6)

2.9 The charge on **B** is now changed to be positive, 3,58 nC.

Explain what will happen to charges **A** and **B**, by referring to the force, charges and the end charge of the system. (4)

[30]

QUESTION 3 (Start on a new page.)

Consider the list of six substances with their formulae and boiling points in the table below.

NAME	FORMULA	BOILING POINT (°C)
Water	H_2O	100
Ethanol	CH_3CH_2OH	78
Bromine	Br_2	58,8
Iodine	I_2	184,3
Ammonia	NH_3	-33,3
Phosphine	PH_3	-87,7

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

3.2 Explain why the boiling point of iodine is so much higher than that of bromine, by referring to the intermolecular forces present in each substance. (4)

3.3 Compare ammonia and phosphine and explain the difference in their boiling points by referring to the intermolecular forces present in each substance. (4)

3.4 Define the term *vapour pressure*. (2)

3.5 Which substance in the table above will have the lowest rate of evaporation? Give a reason for your answer. (3)

3.6 Explain why iodine is not soluble in water by referring to the intermolecular forces in each substance. (3)

[18]

QUESTION 4 (Start on a new page.)

4.1 Consider the reaction between sulphur dioxide and oxygen to produce sulphur trioxide.

4.1.1 Define *1 mole of a substance*. (2)

4.1.2 Write down the balanced chemical equation for the reaction. (3)

If 14 g of sulphur trioxide is produced at STP, calculate:

4.1.3 The volume of sulphur dioxide required in the reaction (4)

4.1.4 The mass of oxygen that has been used up in the reaction (4)

4.2 A compound consists of 85,7% carbon and 14,3% hydrogen. Its molar mass is 56,12 $g \cdot mol^{-1}$.

4.2.1 Calculate the empirical formula of the compound. (5)

4.2.2 Determine the molecular formula of the compound. (2)

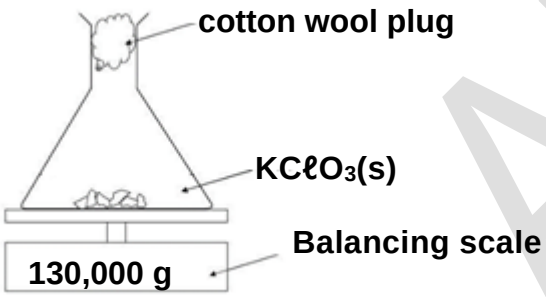
[20]

QUESTION 5 (Start on a new page.)

Potassium chlorate ($KClO_3$) is a strong oxidising agent that has a wide range of uses. It can be a component of explosives, fireworks, safety matches and disinfectants. In a school laboratory, it is used to generate oxygen in the following balanced reaction:

$$\mathbf{2KC\ell O_3(s) \rightarrow 2KC\ell(s) + 3O_2(g)}$$

Two samples of **$KC\ell O_3$** with equal mass of which one is pure and one is impure, are placed in open containers on a balancing scale, as shown in the diagram below.



The table below shows the results obtained.

	Initial mass	Final mass
Pure sample	130 g	79 g
Impure sample	130 g	60,79 g

5.1 Explain why the mass of the flask with its contents decreases. (2)

5.2 Calculate:

5.2.1 The mass of the KCℓ (s) that will form from the impure sample (2)

5.2.2 The mass of the O_2 (g) that will form from the impure sample of **$KC\ell O_3$** (4)

5.2.3 The percentage purity of the impure sample of **$KC\ell O_3$** (4)

[12]

TOTAL: 100

END

DATA FOR PHYSICAL SCIENCES GRADE 11
(PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
(FISIKA)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Gravitational constant *Swaartekragkonstante*	G	6,67 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Radius of Earth *Straal van Aarde*	R_E	6,38 x 10^6 m
Coulomb's constant *Coulomb se konstante*	K	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Charge on electron *Lading op electron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 10^{-31} kg
Mass of the Earth *Massa van die Aarde*	M	5,98 x 10^{24} kg

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

MOTION/BEWEGING

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^{\ 2} = v_i^{\ 2} + 2a\Delta x$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$\mu_s = \frac{f_{s(max)}}{N}$
$\mu_k = \frac{f_k}{N}$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$n_i \sin\theta_i = n_r \sin\theta_r$	$n = \frac{c}{v}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$ $(k = 9{,}0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2})$	$E = \frac{F}{q}$
$E = \frac{kQ}{r^2}$ $(k = 9{,}0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2})$	$V = \frac{W}{Q}$

ELECTROMAGNETISM/*ELEKTROMAGNETISME*

$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$	$\Phi = BA\cos\theta$

CURRENT ELECTRICITY/*ELEKTRIESE STROOMBANE*

$I = \frac{Q}{\Delta t}$	$R = \frac{V}{I}$
$\frac{1}{R} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \ldots$	$R = r_1 + r_2 + r_3 + \ldots$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

DATA FOR PHYSICAL SCIENCES GRADE 11
(CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
(CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
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 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*