ALEXANDER ROAD HIGH SCHOOL

JUNE 2018 | 2 HOUR

PHYSICAL SCIENCES PAPER 2

JA, MH, CO | TOTAL = 100

GRADE 11

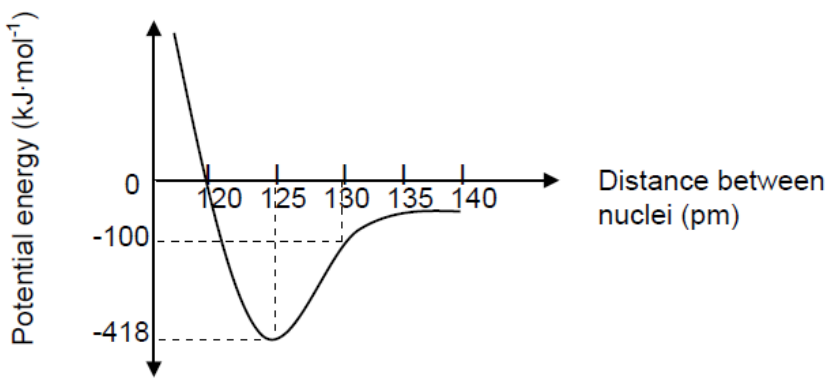
Instructions

- The question paper consists of 6 questions.
- Answer all the questions.
- Answer section A on the answer sheet provided AND section B on folio sheets.
- Rule off after each question in Section B.
- A non-programmable calculator may be used.
- Number the answers correctly according to the numbering system.
- Round off to two (2) decimal places where necessary.
- Formulas have been included at the end of the question paper.
- A periodic table is included on the reverse side of the answer sheet.
- **NOTE: use the graph paper on the last page for Question 6.3**. Detach and staple it after Question 6.2.

QUESTION 1:

Write the answer of the most correct option next to the question number on the A5 answer sheet.

1.1 Which ONE of the following statements is true regarding the graph shown below?



A. The bond energy is $-100\ kJ.mol^{-1}$ and the bond length is $130\ pm$.

B. The bond energy is $-100\ kJ.mol^{-1}$ and the bond length is $120\ pm$.

C. The bond energy is $0\ kJ.mol^{-1}$ and the bond length is $120\ pm$.

D. The bond energy is $-418\ kJ.mol^{-1}$ and the bond length is $125\ pm$.

1.2 Which ONE of the following has the greatest bond energy?

A. $C - C$

B. $C = C$

C. $C \equiv C$

D. $C - H$

1.3 The number of bonds an atom can form is determined primarily by…

A. …the electronegativity of the atom.

B. …the number of unpaired valence electrons present in the atom.

C. …the mass of the atom.

D. …the stability of the atom.

1.4 Which ONE of the following salts has the greatest IONIC CHARACTER?

A. $NaCl$

B. NaF

C. KCl

D. KBr

1.5 Which type of intermolecular force exists between PH_3 molecules?

A. Hydrogen bonds

B. Covalent bonds

C. Dipole-dipole forces

D. London dispersion forces

1.6 Mercury inside a glass tube will have a convex meniscus because…

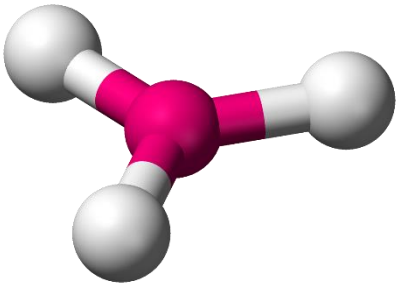
A. …the forces of adhesion between the glass and mercury molecules are WEAKER than the forces of cohesion between the mercury molecules.

B. …the forces of adhesion between the glass and the mercury molecules are STRONGER than the forces of cohesion between the mercury molecules.

C. …the forces of adhesion between the mercury molecules are WEAKER than the forces of cohesion between the glass and mercury molecules.

D. …the forces of adhesion between the mercury molecules are STRONGER than the forces of cohesion between the glass and mercury molecules.

1.7 Which ONE of the following options corresponds to the molecular shape shown in the diagram below?



	Name of Shape	Bond Angle	Example
A	Trigonal planer	All 120°	NH_3
B	Trigonal planer	All 120°	BF_3
C	Trigonal pyramidal	All 120°	NH_3
D	Trigonal pyramidal	All 107°	BF_3

1.8 The chemical analysis of a compound with molecular formula, $C_xH_{2x}O_2$, where x is the number of carbon atoms in 1 molecule of the compound, shows that it contains 12,5% oxygen by mass.

The % by mass of carbon in the compound is:

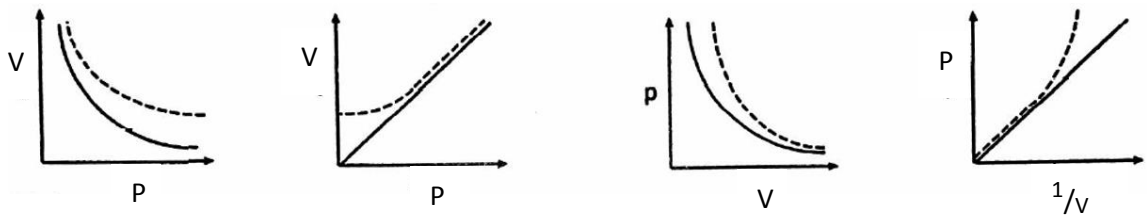
A. 75%

B. 25%

C. 12,5%

D. 87,5%

1.9 Which graph is NOT showing a correct deviation from Ideal gas behaviour? (the solid line/curve represents the Ideal gas behaviour and the dotted line represents the Real gas behaviour.



A **B** **C** **D**

1.10 The pressure on an enclosed gas is P_{old}. If the temperature is doubled and the volume is tripled, the new Pressure will be P_{new}. The relationship beteen P_{old} and P_{new} will be:

A $P_{new} = 0,67 \times P_{old}$

B $P_{new} = {}^{3}/_{2} \times P_{old}$

C $P_{old} = 0,67 \times P_{new}$

D $P_{old} = 1,5 \times P_{new}$

QUESTION 2

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

2.2 Consider the three compounds CH_4, NH_3 and H_2O. The same type of INTRAmolecular force holds all three compounds together.

2.2.1 Write down the NAME of this intramolecular force. (1)

2.2.2 Explain how the intramolecular force mentioned in 2.2.1 is formed. (1)

2.3 Draw the Lewis structure of the following molecules:

2.3.1 H_2O (2)

2.3.2 CH_4 (2)

2.4 Using the VSEPR model, predict the shape of the:

2.4.1 H_2O molecule (1)

2.4.2 CH_4 molecule (1)

2.5 Compare the polarity of the H_2O and CH_4 molecules by referring to the POLARITY OF THE BONDS and the EFFECT OF THE SHAPE (including the reason for the effect) of each molecule on its polarity. (5)

2.6 Water (H_2O) is able to form a bond with the hydrogen ion (H^+) to form the hydronium ion (H_3O^+).

2.6.1 What is the name of this type of bond? (1)

2.6.2 Explain why the nitrogen atom in ammonia (NH_3) is also able to form the bond mentioned in question 2.6.1. (2)

[18]

QUESTION 3

3.1 For the substances mentioned in 3.1.1 to 3.1.5 write down the NAME of the most important intermolecular forces.

3.1.1 Between the molecules of carbon dioxide (CO_2). (1)

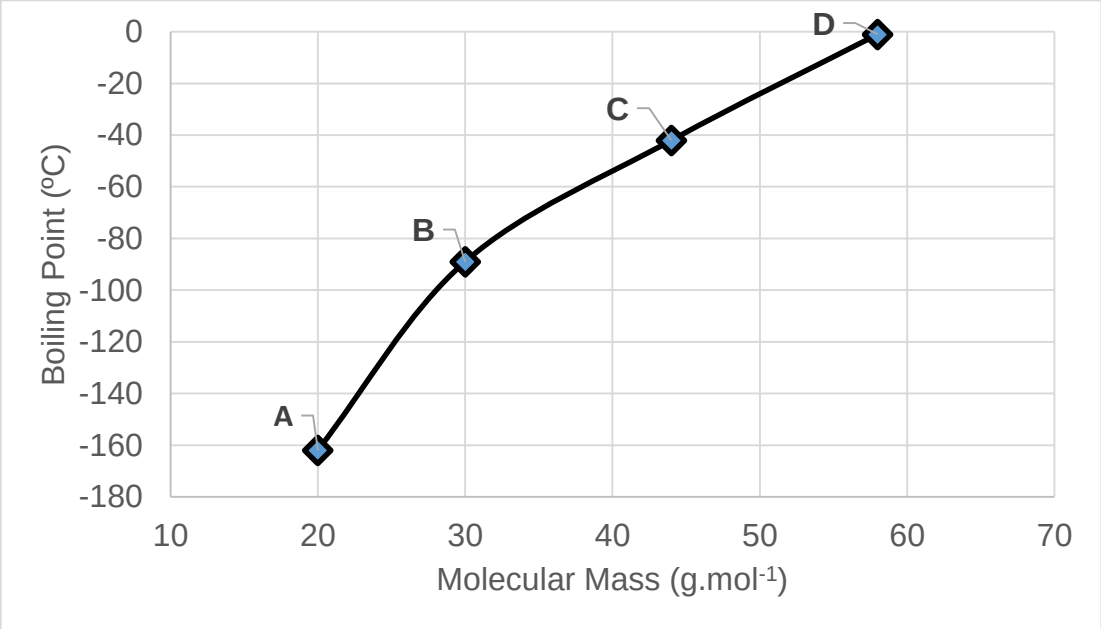
3.1.2 Between the molecules of hydrofluoric acid (HF). (1)

3.1.3 Between the molecules of hydrogen sulphide (H_2S). (1)

3.1.4 Between the molecules of carbon tetrachloride (CCl_4) and hydrochloric acid (HCl). (1)

3.1.5 In an aqueous solution of magnesium chloride ($MgCl_2$) (1)

3.2 The graph of boiling point versus molecular mass is given below. A, B, C and D represent non-polar molecules CH_4, C_2H_6, C_3H_8 and C_4H_{10} respectively.



3.2.1 Describe the trend in the boiling points FROM CH_4 to C_4H_{10} as shown on the graph above. (2)

3.2.2 Explain your answer to QUESTION 3.2.1. As part of your answer, refer to the TYPE and RELATIVE STRENGTH of the INTERMOLECULAR FORCES. (3)

3.2.3 Which one of CH_4, C_2H_6, C_3H_8 and C_4H_{10} will have the LOWEST vapour pressure? (1)

3.3 Water (H_2O) is a molecule without which life on Earth would not exist. It has many unique physical properties.

3.3.1 One of water's most remarkable physical properties is that ice is less dense than liquid water. Explain why this is so by referring to the ARRANGEMENT of the molecules in ice. (2)

3.3.2 What is the biological significance of ice being less dense than water? (2)

[15]

QUESTION 4

4.1 Define the term *molar mass.* (1)

4.2 The molecular mass of a substance found in a controversial medicinal plant is 118 $g.mol^{-1}$. When analysed, it was found that the plant contained approximately 41% C, 5% H and 54% O by mass. Calculate the molecular formula of the substance. (6)

4.3 Metanol (CH_3OH) can be burnt in O_2 to produce energy or decomposed to form hydrogen gas which is a useful fuel. Consider the following balanced reaction where methanol is decomposed to form hydrogen:

$$CH_3OH\ (l) \rightarrow 2H_2\ (g) + CO\ (g)$$

If 250 g of methanol is decomposed at STP and 300 dm^3 of hydrogen gas is obtained, what is the percentage yield for this reaction? (10)

4.4 100,8g of magnesium carbonate is treated with 250cm^3 of a 6 $mol.dm^{-3}$ nitric acid solution and CO_2 is collected from the reaction.

$$MgCO_3 + 2\ HNO_3 \rightarrow Mg(NO_3)_2 + H_2O + CO_2$$

Calculate which reagent ($MgCO_3$ or HNO_3) is in excess. (8)

[25]

QUESTION 5

5.1 Draw a rough potential energy diagram (graph) for the following reaction:

$$NO_2(g) + CO(g) \rightarrow CO_2(g) + NO(g) \qquad \Delta H = -226\ kJ.mol^{-1}$$

Activation energy = 134 $kJ.mol^{-1}$.

Show the potential energy on the *y*-axis and the progress of the reaction on the *x*-axis. Indicate the activation energy (E_A) and the reaction energy or enthalpy change (ΔH) on your diagram. (3)

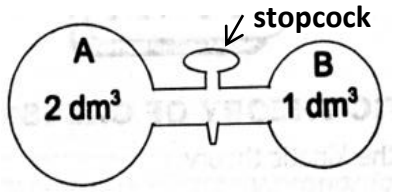
5.2 Indicate on the diagram above by using a dotted line curve, the change in the shape of the graph if a catalyst is used. (1)

5.3 If 134 $kJ.mol^{-1}$ was used to activate this reaction, calculate the amount of energy given off when the products are formed? (2)

[6]

QUESTION 6

6.1 The diagram shows two containers that are connected by a thin tube with a closed stopcock. Container A contains air at a pressure of 100 kPa. Initially there is a vacuum in Container B. When the stopcock is opened, while the temperature remains constant, the air flows from A to B. Calculate the pressure in container A if the stopcock remains open?



Ignore the volume of the thin tube. (3)

6.2 A certain mass of CO_2 gas occupies a volume of 0,8 m^3 at 25 °C and a pressure of 1,4 x 10^5 kPa. Calculate the mass (in gram) of the CO_2 in the container. (4)

DO THE <u>WHOLE</u> OF QUESTION 6.3 ON THE PROVIDED GRAPH PAPER. DETACH THE PAGE AND STAPLE IT AFTER QUESTION 6.2.

6.3 The following results were obtained by learners investigating gas behaviour.

Gas volume (cm^3)	66	74	80	86	90
Temperature (◦C)	0	27	52	77	100
Pressure (kPa)	90	90	90	90	90

6.3.1 Plot at least 3 of these results on the graph paper provided on the reverse side of the answer sheet. Draw a line of best fit. (3)

6.3.2 Extrapolate the graph with a dotted line and determine at which temperature the graph intersects the temperature axis. Indicate the value on your graph. (2)

6.3.3 How will the gradient of the graph be affected if a greater mass of gas is used? Only write INCREASE, DECREASE or STAY THE SAME in the space provided. (1)

6.3.4 What is the name of the <u>gas law</u> that was investigated here? (1)

6.3.5 State this law as a mathematical relationship (not in words). (1)

6.3.6 What is the control variable in this investigation? (1)

[16]

TOTAL [100]

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·K^{-1}·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·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* $c=\frac{m}{MV}$

QUESTION 6.3

6.3.3 _____

6.3.4 _____

6.3.5 _____

6.3.6 _____