ALEXANDER ROAD HIGH SCHOOL

November 2021	**PHYSICAL SCIENCES ASSESSMENT PAPER 2**	180 MINUTES
CO, JA, MH	**GRADE 11**	TOTAL = 150

Instructions:

- The question paper consists of 8 questions.
- Answer all the questions.
- Answer section A on the answer sheet provided AND section B on folio sheets.
- 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.
- A formula sheet and Table 4B of standard reduction potentials have been provided at the end of the question paper.
- A periodic table has been provided on the back of the answer sheet.

SECTION A

(answer on the answer sheet)

QUESTION 1:

Four possible options are provided as answers to the following questions. Each question has only one correct answer. Choose the correct answer and write the letter (A – D) next to the relevant question number (1.1 – 1.10) on the answer sheet.

1.1 Which ONE of the following has the greatest mass?

A. One chlorine atom
B. One chlorine molecule
C. One mole of chlorine
D. One gram of chlorine

1.2 What type of intermolecular force exists between NaCℓ (aq) and $CC\ell_4$ molecules?

A. Ion-dipole forces

B. Dipole-dipole forces

C. Ion-induced dipole forces

D. London forces

1.3 If a central atom has a lone pair, what effect does it have on the molecule shape?

A. No effect.

B. The molecule is planar.

C. The molecular is not linear or planar.

D. The molecule is non-polar.

1.4 A standard solution is a solution of known…

A. …temperature.

B. …concentration.

C. …pressure.

D. …volume only.

1.5 Which one of the following statements about a chemical reaction is TRUE?

The theoretical yield of a chemical reaction is…

A. …equal to the percentage yield.

B. …equal to the percentage purity.

C. …less than the actual yield.

D. …greater than the actual yield.

1.6 A real gas deviates from ideal gas behaviour at…

A. …high pressures because the volume of the gas particles becomes significant.

B. …high pressures because the gas occupies a larger volume.

C. …high temperatures because the gas particles stick together causing less collisions per unit area.

D. …high temperatures because the gas can't handle the heat.

1.7 Which ONE of the following statements CORRECTLY describes the characteristics of an exothermic reaction?

A. $\triangle H$ is positive and the products have less potential energy than the reactants.

B. $\triangle H$ is positive and the products have more potential energy than the reactants.

C. $\triangle H$ is negative and the products have less potential energy than the reactants.

D. $\triangle H$ is negative and the products have more potential energy than the reactants.

1.8 Consider the incomplete BALANCED chemical equation below.

$$X + 2\,HC\ell \rightarrow ZnC\ell_2 + H_2O + CO_2$$

Which ONE of the following is represented by X in the above equation?

A. $ZnCO_3$

B. $ZnHCO_3$

C. $ZnCO_2$

D. $Zn(OH)_2$

1.9 A substance that *donates* electrons during a chemical reaction is a/an…

A. …Lowry-Brønsted acid.

B. …Lowry-Brønsted base.

C. …reducing agent.

D. …oxidising agent.

1.10 During the extraction of gold, zinc powder is added to a solution of gold cyanide to produce gold according to the following balanced equation:

$$Zn\,(s) + 2\,NaAu(CN)_2\,(aq) \rightarrow 2\,Au\,(s) + Zn(CN)_2\,(aq) + 2\,NaCN\,(aq)$$

The oxidising agent in this reaction is

A. Au^+

B. Zn

C. Zn^{2+}

D. Au

TOTAL SECTION A = [20]

SECTION B

(answer on folio paper)

QUESTION 2 (start this question on a new side of a page):

Consider the following molecules and answer the questions that follow.

A	NH_3
B	CO_2
C	N_2
D	H_2O
E	BH_3

2.1 For the following questions only write down the letter from the table above.

Which molecule…

2.1.1 …is trigonal planar? (1)

2.1.2 …is angular in shape and contains a centre atom with two lone pairs? (1)

2.1.3 …contains a triple bond? (1)

2.1.4 …will form the same shape of molecule than AsH_3? **Explain your answer.** (3)

2.2.1 Which TWO molecules can form a dative covalent bond with a hydrogen ion? Only write down the letters of the correct substances. (2)

2.2.2 NAME the two substances that will form when the molecules in 2.2.1 form a dative covalent bond with a hydrogen ion. (2)

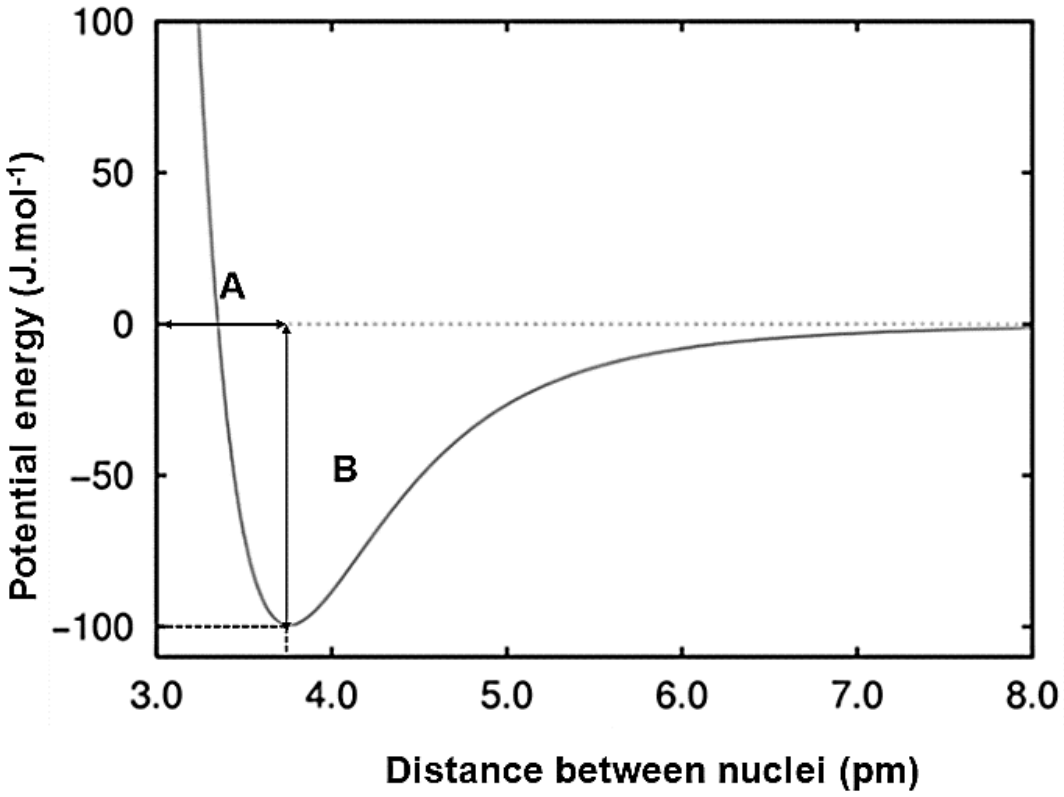
2.2.3 Explain the difference between a dative covalent bond and a covalent bond. (4)

2.3.1 Draw a Lewis diagram of the CO_2 molecule. (2)

2.3.2 Are the bonds in the CO_2 molecule POLAR or NON-POLAR? **Justify your answer** with an appropriate calculation. (2)

2.3.3 Draw the Couper notation of the CO_2 molecule indicating any partial charges using δ^+ and δ^-. (3)

2.4 Consider the bonding curve/graph for the formation of a diatomic molecule.



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

2.4.2 Write down the labels for A and B. (2)

2.4.3 How much energy would 3 mol of this molecule need to be broken? (2)

2.4.4 How far are the atoms from each other when the actual bond has formed? (1)

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QUESTION 3 (start this question on a new side of a page):

3.1 Explain the difference between an intramolecular and intermolecular force. (2)

3.2 Consider NH_3.

3.2.1 Name the type of intramolecular force present. (1)

3.2.2 Name the type of intermolecular force present. (1)

3.3 Consider a liquid mixture of NH_3 and H_2O.

3.3.1 Name the type of intermolecular force present between the different molecules. (1)

3.3.2 The mixture is now separated using fractional distillation. Which substance will reach boiling point first? (1)

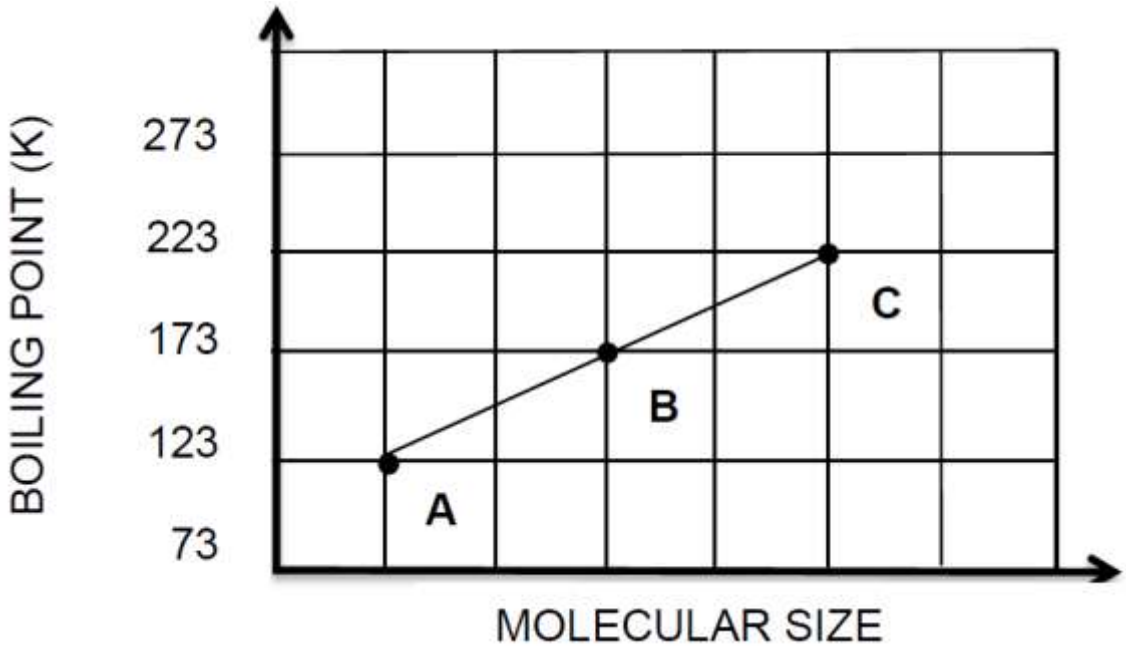
3.3.3 Define the term *boiling point*. (2)

3.3.4 Under the right conditions, a reaction will occur between NH_3 and H_2O. Write a balanced equation for this reaction. (2)

3.3.5 Is the product(s) BASIC or ACIDIC? **Give a reason for your answer**. (2)

3.4 Consider the molecules HF and HCl. HF has a smaller molecular mass and similar shape as HCl but the boiling point of HF is 19,5 ºC and whereas that of HCl is -85,05 ºC. Explain the difference in the boiling points by referring to the TYPE and STRENGTH of INTERMOLECULAR FORCES. (4)

3.5 The graph of molecular size versus the boiling point is given below.



The letters **A**, **B** and **C** represent the non-polar molecules CH_4, C_2H_6 and C_3H_8 respectively.

3.5.1 Describe the trend in the boiling points of the compounds shown on the graph. (2)

3.5.2 Explain the answer to QUESTION 3.5.1 by referring to MOLECULAR SIZE, TYPE and STRENGTH of INTERMOLECULAR FORCES. (3)

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QUESTION 4 (start this question on a new side of a page):

4.1 The molecular mass of an unknown substance is 93 $g.mol^{-1}$. When analysed, it was found that the substance contained approximately 38,8% C, 16,1% H and 45,1% N.

4.1.1 Define the term *empirical formula of a compound*. (2)

4.1.2 Calculate the molecular formula of the substance. (6)

4.2 154 g of sodium carbonate (Na_2CO_3) is treated with 500 cm^3 of a 5 $mol.dm^{-3}$ hydrochloric acid ($HC\ell$) solution. 21 dm^3 of CO_2 is collected from the reaction at STP.

$$Na_2CO_3 + 2\,HC\ell \rightarrow 2\,NaC\ell + H_2O + CO_2$$

4.2.1 Determine, by calculation, which reagent is the limiting reagent. (8)

4.2.2 Calculate the percentage yield for the reaction. (5)

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QUESTION 5 (start this question on a new side of a page):

The pressure in a 5 dm^3 balloon is 101,3 kPa. A naughty toddler jumps on the balloon rapidly decreasing its volume to 2 dm^3.

5.1 State *Boyle's Law* in words. (2)

5.2. When the naughty toddler jumps on the balloon, does the pressure in the balloon INCREASE, DECREASE or REMAIN THE SAME? **Explain**. (2)

5.3 If the maximum pressure the balloon's wall can withstand is 200 kPa, will the balloon burst when the naughty toddler jumps on it? **Justify your answer** with an appropriate calculation. (3)

5.4 The pressure inside a 5 dm^3 balloon is greater on a hotter day. Use your knowledge of the kinetic molecular theory (KMT) of gases to explain this observation. (3)

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QUESTION 6 (start this question on a new side of a page):

N_2O decomposes to form nitrogen gas and oxygen gas according to the following balanced equation:

$$2\ N_2O\ (g)\ +\ 167\ kJ.mol^{-1}\ \rightarrow\ 2\ N_2\ (g)\ +\ O_2\ (g)$$

The activation energy (E_A) for this reaction is 251 kJ.mol^{-1}.

6.1 Define the term *activation energy*. (2)

6.2 Is this reaction ENDOTHERMIC or EXOTHERMIC? **Explain**. (2)

6.3 Sketch a potential energy versus coordinate graph for the above reaction. Clearly label the axes and indicate the following on the graph:

- $\triangle H$
- E_A for the reaction
- Reactants (R) and products (P)
- Activated complex (X)

(4)

6.4 If 2 mol of N_2O decomposes, write down the value of the:

6.4.1 Heat of reaction (2)

6.4.2 Activation energy for the reaction (2)

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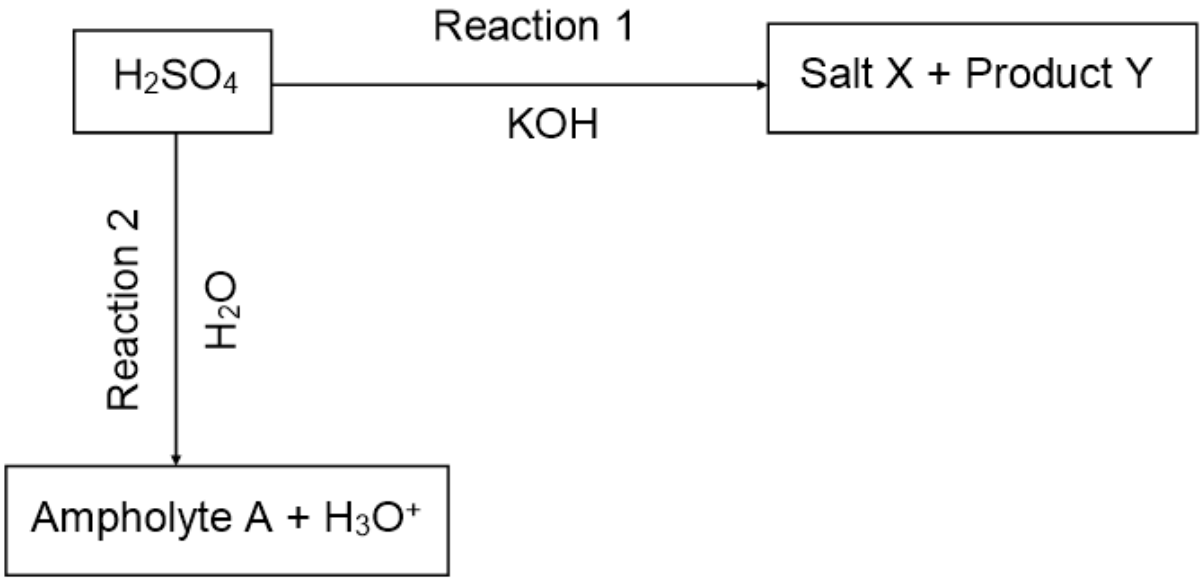
QUESTION 7 (start this question on a new side of a page):

Two reactions of sulphuric acid are shown in the diagram below.



7.1 Define the term *ampholyte.* (2)

7.2 Write down the FORMULA of ampholyte A. (1)

7.3 Define a *Lowry-Brønsted acid*. (2)

7.4 Give the FORMULAE of TWO conjugate acid-base pair in Reaction 2. (4)

7.5 Write down a balance equation for Reaction 1. (3)

7.6 Write down the NAME of the salt represented by X. (1)

7.7 Name the type of acid-base reaction in Reaction 1. (1)

7.8 During a titration, 50 cm^3 of a 0,1 $mol.dm^{-3}$ solution of ammonia, is placed in a conical flask. A few drops of methyl orange are added to the flask. 25 cm^3 of sulphuric acid is needed to neutralise the ammonia according to the following balanced equation:

$$H_2SO_4\ (aq)\ +\ 2\ NH_3\ (aq) \rightarrow\ (NH_4)_2SO_4\ (aq)$$

7.8.1 State the *colour change* of the indicator. (2)

7.8.2 Calculate the concentration of the sulphuric acid. (5)

7.8.3 The water is evaporated from the salt solution that formed. Calculate the mass of the salt produced. Assume a 100% yield. (4)

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QUESTION 8 (start this question on a new side of a page):

The reaction between dichromate ions and iron (II) ions are given in the UNBALANCED chemical equation below:

$$Cr_2O_7^{2-}\ (aq)\ +\ Fe^{2+}\ (aq)\ \rightarrow\ Cr^{3+}\ (aq)\ +\ Fe^{3+}\ (aq)$$

8.1 Define the term *reduction* in terms of oxidation numbers. (2)

8.2 Calculate the oxidation number of chromium in $Cr_2O_7^{2-}$. (1)

8.3 Write down the FORMULA of the substance that undergoes reduction. (1)

8.4 Define *reducing agent* in terms of electron transfer. (2)

8.5 Write down the FORMULA of the reducing agent. (1)

8.6 How does the reducing agent, identified in 8.5, compare to zinc (Zn)? Only state STRONGER or WEAKER. (1)

8.7 Write down the balance equation for the reaction in an alkaline medium by using half reactions. (5)

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TOTAL SECTION B = [130]

Formula Sheet

Physical Constants:

Name	Symbol	Value
Acceleration due to gravity	g	9,8 $m.s^{-2}$
Avogadro's constant	N_A	$6,02 \times 10^{23}$ mol^{-1}
Molar gas constant	R	8,31 $J.K^{-1}.mol^{-1}$
Standard pressure	p^{θ}	$1,013 \times 10^5$ Pa
Molar gas volume at STP	V_m	22,4 $dm^3.mol^{-1}$
Standard temperature	T^{θ}	273 K

Formulae:

CHEMISTRY

$p_1V_1 = p_2V_2$	
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or $c = \frac{m}{MV}$