Anglo-Chinese School
(Independent)

YEAR 6 PRELIMINARY EXAMINATION 2019
INTERNATIONAL BACCALAUREATE DIPLOMA PROGRAMME
CHEMISTRY HIGHER LEVEL

PAPER 3

Friday **20th September 2019** **1 hour 15 minutes**

Candidate Session Number

0	0	2	3	2	9				

INSTRUCTIONS TO CANDIDATES

- Do not open this examination paper until instructed to do so.
- Write your **candidate session number in the box above**.
- A calculator is required for this paper.
- A copy of the Chemistry Data Booklet is required for this paper.
- Answer **all** questions from Section A and Section B in the boxes provided.
- If you use additional sheets of paper for your answer, attach them to the booklet. Indicate the question number clearly on these sheets.
- The maximum mark for this examination paper is **45 marks**.

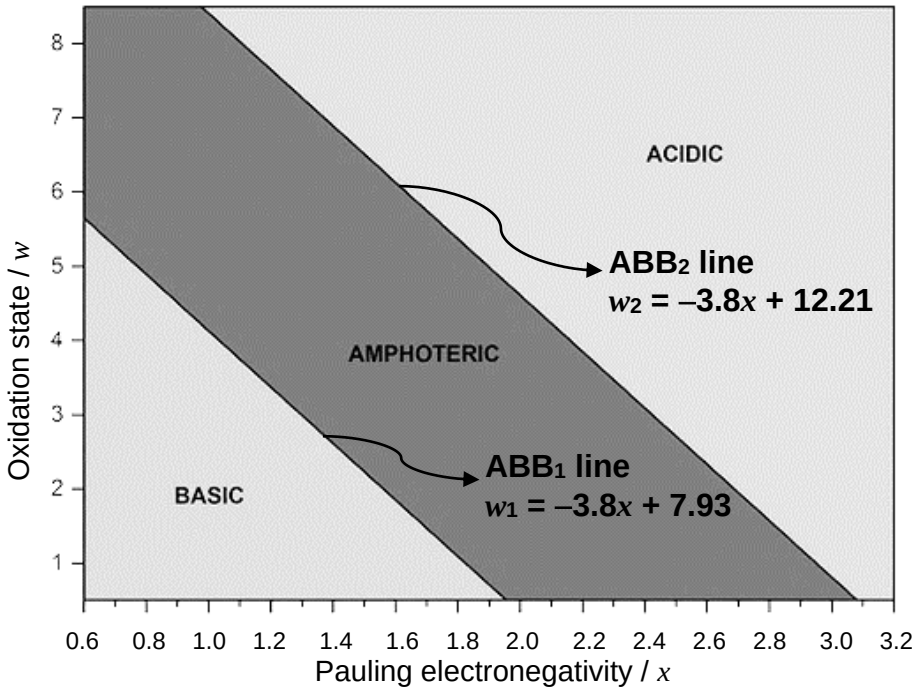
For examiner's use	
Section A	
Qn 1	/8
Qn 2	/7
Section B	
Qn 3	/8
Qn 4	/6
Qn 5	/8
Qn 6	/4
Qn 7	/4
Total	/45

This question paper consists of 12 printed pages including this cover page.

Section A

Answer **all** questions. Write your answers in the boxes provided.

1. The educational chart below illustrates the acid-base behaviour of element oxides based on the Pauling electronegativity and oxidation state of the element.



Source: "acid-base behaviour of 100 element oxides: Visual and mathematical representations", Journal of Chemical Education

It provides a periodic trend method and a mathematical method to better understand the acid-base behaviour of oxides. The two lines, ABB_1 and ABB_2, are the lower and upper acid-base behaviour boundaries that are drawn to separate the chart into three areas of basic, amphoteric and acidic oxides and can be mathematically expressed with a set of equations. The bottom line (ABB_1) separates the basic oxides from the amphoteric oxides and has the following equation: $w_1 = -3.8x + 7.93$. The top line (ABB_2) separates the amphoteric oxides from the acidic oxides and has the following equation: $w_2 = -3.8x + 12.21$.

General acid-base behaviour can be calculated for any oxide using the formula:

$$ABB = 3.8x + w$$

where ABB = Acid-base behaviour
x = Pauling electronegativity
w = oxidation state of element in the oxide

The lower boundary line is denoted as $ABB_1 = 7.93$ and the upper boundary line is denoted as $ABB_2 = 12.21$. The calculated ABB value is compared with the ABB_1 and ABB_2 values corresponding to the boundaries to predict the acid-base behaviour.

(This question continues on the following page.)
(Question 1 continued)

	Type of oxide
ABB < ABB_1	basic
ABB_1 < ABB < ABB_2	amphoteric
ABB > ABB_2	acidic

Table 1 below shows some examples of the oxides from s-, p-, d-, and f-elements with their ABB Values.

s-block	**Name of element**	**ABB value**
Li_2O	Lithium	4.80
Na_2O	Sodium	4.42
Cs_2O	Caesium	4.04
MgO	Magnesium	6.94
BaO	Barium	5.42

d-block	**Name of element**	**ABB value**
Sc_2O_3	Scandium	8.32
VO_2	Vanadium	10.08
NiO	Nickel	9.22
CdO	Cadmium	8.46
Y_2O_3	Yttrium	7.56

p-block	**Name of element**	**ABB value**
Al_2O_3	Aluminium	9.08
CO_2	Carbon	13.88
SiO_2	Silicon	11.22
P_4O_6	Phosphorus	11.36
SO_2	Sulfur	13.88

f-block	**Name of element**	**ABB value**
La_2O_3	Lanthanum	7.18
Ac_2O_3	Actinium	7.18
CeO_2	Cerium	8.26
PrO_2	Praseodymium	8.29
Nd_2O_3	Neodymium	7.33

Table 1

(a) Using the formula given and information from section 8 of the data booklet, calculate the ABB values of As_2O_3 and As_2O_5. [2]

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(This question continues on the following page.)
(Question 1 continued)

(b) Hence, predict the acid-base behaviour of As_2O_3 and As_2O_5. [2]

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(c) Refer to the ABB value in Table 1, suggest a chemical test, with the help of a relevant equation, which can determine the acid-base behaviour of Cs_2O. [2]

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(d) What is the advantage of using this educational chart in predicting the acid-base behaviour of element oxide? [1]

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(e) By referring to the element oxides from p block given in table 1, state **one** reason to justify why the effective applicability of the chart is not 100%. [1]

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2. A student was asked to determine the concentration of sodium hypochlorite, NaClO, in a commercially available bleach. Hypochlorite is converted to chloride ions in the presence of an acid and aqueous potassium iodide, producing brown-coloured iodine molecules.

The student decided to carry out titrimetric analysis according to the steps below.

Step 1: Pipette 25.0 cm^3 of bleach into a 250 cm^3 volumetric flask and make up to the mark with distilled water. Shake well to obtain a homogenous solution. Label the solution FA 1.

Step 2: Pipette 25.0 cm^3 of FA 1 into a conical flask. Add 10 cm^3 of excess aqueous potassium iodide and 10 cm^3 of 1.0 mol dm^{-3} sulfuric acid to the flask. Label the solution mixture as FA 2.

Step 3: Fill the burette with 19.78 g dm^{-3} of sodium thiosulfate, $Na_2S_2O_3$. Add about 1 cm^3 of starch indicator into FA 2 and titrate until a colour change is observed. Record the results.

Step 4: Repeat steps 2 to 3 as many times as necessary to obtain consistent titration results to within ±0.10 cm^3.

(a) Write an ionic equation for the reaction between aqueous sodium hypochlorite, dilute sulfuric acid and an excess of aqueous potassium iodide. [1]

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(b) Explain, with the help of an equation, what is the role of sodium thiosulfate solution in this experiment. [2]

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(This question continues on the following page.)
(Question 2 continued)

(c) State what you would observe at the end-point of the titration in step **3**. [1]

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(d) State a systematic error in the experiment and thus state a relevant suggestion for improvement. [2]

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(e) Another student decided to carry out the same experiment but he replaced dilute sulfuric acid with dilute hydrochloric acid in step 2. State, giving a reason, whether the change will introduce a random or systematic error. [1]

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Section B

Option D – Medicinal chemistry

Answer **all** questions. Write your answers in the boxes provided.

3. (a) Drug testing is necessary to determine safe and effective doses. Distinguish between the therapeutic index in animal studies and the therapeutic index in humans. [2]

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(b) Outline the meaning of the *bioavailability* of a drug. [1]

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(c) Refer to section 37 of the data booklet and formulate an equation for the conversion of aspirin to a more water soluble derivative to increase its bioavailability. [1]

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(This question continues on the following page.)
(Question 3 continued)

(d) (i) A sample of aspirin was prepared from salicyclic acid in the laboratory. [2]

The product was extracted from the reaction mixture, and the sample was dried and the melting point determined. However, when compared to the literature value for melting point of pure aspirin which is 136 °C, its melting point was found to be 122−128 °C. Suggest why this is so.

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(ii) Organic molecules can also be characterized using infrared (IR) spectroscopy. [1]

State **one** difference between the infrared spectra above 1500 cm^{-1} for pure samples of aspirin and salicylic acid using section 26 of the data booklet.

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(iii) Explain why aspirin is **not** stored in a hot, humid location. [1]

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4. (a) (i) Explain, in terms of structure, why diamorphine is a more potent drug than morphine. [2]

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(ii) State a reagent that could be used to convert morphine into diamorphine and name the type of reaction taking place. [2]

Reagent : …….....

Type of reaction : .....

(b) Oseltamivir (Tamiflu) and zanamivir (Relenza) are used against flu viruses. Outline **two** ways in which antiviral medications work. [2]

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5. (a) Outline **three** ways how the activities of humans have created an increase in the resistance to penicillin in bacteria populations. [3]

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(b) Suggest why human cells are not affected by penicillin. [1]

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(c) The production of many pharmaceutical drugs produces a lot of waste solvents. [2]

State **two** green solutions to the problem of organic solvent waste.

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(d) Using omeprazole as an example, explain the term '*active metabolite'* as applied to drugs. [2]

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6. Paclitaxel (Taxol) is a chemotherapy medication used to treat a number of cancers. Besides chemotherapy, boron neutron capture therapy (BNCT) can be used in the treatment of brain and neck tumours.

(a) Outline how paclitaxel can be used as an effective treatment for cancer. [2]

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(b) By use of **two** suitable equations, explain how boron-10 is used in boron neutron capture therapy (BNCT) for the treatment of brain tumour through alpha emission. [2]

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7. (a) The vapour pressures of pure benzene and pure methylbenzene at 20 ^{o}C are 10.00 kPa and 2.93 kPa. [3]
Calculate the total vapour pressure of an ideal solution containing 2.00 moles of benzene and 2.50 moles of methylbenzene.

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(b) Calculate the mole fraction of benzene in the vapour. [1]

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End of paper