

Class	Register Number	Name
-------	-----------------	------



南洋女子學校
NANYANG GIRLS' HIGH SCHOOL

Mid-Year Examination 2017
Secondary Three IP Chemistry

CHEMISTRY

1 hour 30 minutes

Monday

8 May 2017

0845 - 1015

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name in the spaces at the top of this page.
Do not use paper clips, glue or correction fluid.

There are 3 sections in this paper.

Section A

Answer all questions.

For each question there are four possible answers **A**, **B**, **C** and **D**. Choose the one you consider correct and record your choice in the OAS sheet provided.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Section B and C

Answer all questions. The number of marks is given in brackets [] at the end of each question or part question.

Candidates are reminded that all quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner.

A copy of the Periodic Table is on page **16**.

Section A (20 marks)	
Section B (30 marks)	
Section C (10 marks)	
Total (60 marks)	

- 1 Which of the following is the best method to collect gases less dense than air?
- A** upward delivery
B downward delivery
C upward displacement of air
D downward displacement of water
- 2 What is the mass of 1 tungsten atom? (A_r of tungsten = 183.8)
- A** 1.10×10^{-26} g
B 6.00×10^{-23} g
C 3.06×10^{-22} g
D 183.8 g
- 3 Nitrogen is an essential element required for protein synthesis in plants. Which of the following nitrogenous compounds listed below would provide the highest mass of nitrogen per 300 g of compound?
- A** ammonium nitrate
B urea, NH_2CONH_2
C ammonium phosphate
D ammonium chloride
- 4 The molecular formula of aspirin is $\text{C}_9\text{H}_8\text{O}_4$. A typical aspirin tablet contains 325 mg of $\text{C}_9\text{H}_8\text{O}_4$. How many molecules of aspirin are in a tablet? (1 g = 1000 mg)
- A** 0.00181
B 1.08×10^{21}
C 5.85×10^{24}
D 5.54×10^{25}
- 5 Which one of the following is the molecular formula of a hydrocarbon containing 85.7% of carbon by mass?
- A** CH_4
B C_2H_4
C C_3H_8
D C_4H_{10}

- 6 What is the concentration of nitrate ions in a solution of $0.0500 \text{ mol dm}^{-3}$ zinc nitrate?
- A $0.0500 \text{ mol dm}^{-3}$
B $0.100 \text{ mol dm}^{-3}$
C $0.150 \text{ mol dm}^{-3}$
D $0.250 \text{ mol dm}^{-3}$
- 7 Succinic acid is an organic acid. When burnt in excess oxygen, 0.150 mol of succinic acid produces 14.4 dm^3 of carbon dioxide and 8.10 g of water. What is the formula of succinic acid?
- A $\text{C}_2\text{H}_3\text{O}_2$
B $\text{C}_2\text{H}_6\text{O}_4$
C $\text{C}_4\text{H}_3\text{O}_2$
D $\text{C}_4\text{H}_6\text{O}_4$
- 8 9.00 dm^3 of impure hydrogen reacted with excess nitrogen to form 3.00 dm^3 of ammonia. What is the percentage purity of the hydrogen sample?
- A 33.3%
B 50.0%
C 60.0%
D 66.7%
- 9 Sulfuryl chloride gas, SO_2Cl_2 , decomposes when heated to form sulfur dioxide gas and chlorine gas. What is the total volume of gases produced when 26.2 dm^3 of sulfuryl chloride decomposes?
- A 13.1 dm^3
B 26.2 dm^3
C 52.4 dm^3
D 78.6 dm^3
- 10 Which of the following solutions would have the **lowest** pH?
- A 1.0 mol dm^{-3} of hydrochloric acid
B 1.0 mol dm^{-3} of sodium chloride
C 1.0 mol dm^{-3} of ethanoic acid
D 1.0 mol dm^{-3} of sodium hydroxide

- 11** The salt **AB** is prepared by reacting the carbonate of **A** with the acid **HB**. The titration method is used to prepare the salt. What are the solubilities of the carbonate, the acid and the salt?

	<u>carbonate of A</u>	<u>acid HB</u>	<u>salt AB</u>
A	insoluble	soluble	insoluble
B	insoluble	soluble	soluble
C	soluble	insoluble	insoluble
D	soluble	soluble	soluble

- 12** Which of the following salts can be prepared by crystallisation from an aqueous solution?

- A** barium sulfate
- B** lead(II) carbonate
- C** potassium nitrate
- D** silver chloride

- 13** Which of the following reactants can be used to safely prepare potassium chloride?

- A** aqueous potassium hydroxide and dilute hydrochloric acid
- B** aqueous potassium carbonate and aqueous sodium chloride
- C** potassium metal and aqueous sodium chloride
- D** potassium metal and dilute hydrochloric acid

- 14** Which pair of substances is used for making copper(II) sulfate?

- A** copper and aqueous zinc sulfate
- B** copper and dilute sulfuric acid
- C** copper(II) carbonate and aqueous sodium sulfate
- D** copper(II) oxide and dilute sulfuric acid

- 15** Hydrochloric acid is added to a beaker containing litmus solution. An excess of aqueous sodium hydroxide is then added to the mixture.

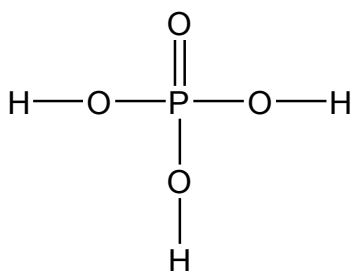
What is one product of the reaction and what is the final colour observed in the mixture?

	<u>product</u>	<u>colour</u>
A	hydrogen	red
B	sodium chloride	blue
C	carbon dioxide	blue
D	sodium chloride	red

16 What is the **most** likely structural formula for the covalent compound S_2Cl_2 ?

- A $Cl = S - S = Cl$
B $Cl - S - S - Cl$
C $S - Cl - Cl - S$
D $S - Cl - S - Cl$

17 The bonding in phosphoric acid can be represented by the structural formula shown.



What is the total number of electrons shared between the phosphorus and oxygen atoms?

- A 5
B 8
C 10
D 16

18 Iodine has a higher boiling point compared to chlorine. Which statement best explains this?

- A Iodine is a solid and not a gas
B Iodine has stronger covalent bonds in the molecule than chlorine
C The intermolecular forces of attraction between the molecules in iodine are stronger than in chlorine
D Chlorine molecules have a lower relative molecular mass than iodine molecules.

19 The proton number of phosphorus is 15. Which compound of phosphorus is likely to exist?

1 Na_3P

2 PCl_3

3 Ca_3P_2

- A Compound 1 only
B Compounds 1 and 2 only
C Compounds 2 and 3 only
D Compounds 1, 2 and 3

- 20** The formula of the compound formed by the sodium ion and the oxalate ion is $\text{Na}_2\text{C}_2\text{O}_4$. Which of the following is **most** likely to be a correct chemical formula?

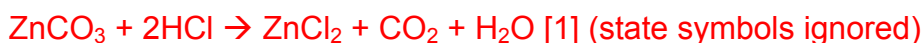
- A** $\text{Al}_3(\text{C}_2\text{O}_4)_2$
- B** $\text{Ca}_2\text{C}_2\text{O}_4$
- C** $\text{Fe}(\text{C}_2\text{O}_4)_2$
- D** MgC_2O_4

Section B

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

B1 An excess of zinc carbonate was added to 10 cm³ of 0.5 mol dm⁻³ hydrochloric acid. The gas produced was collected via the displacement of water.

- (a) Calculate the maximum volume of gas at r.t.p. which could be produced in the reaction. [4]



$$n_{\text{HCl}} = \frac{10}{1000} \times 0.5 = 0.00500 \text{ mol}$$
 [1]

$$n_{\text{CO}_2 \text{ produced}} = 0.005 \div 2 = 0.00250 \text{ mol}$$
 [1]

$$\text{Volume of CO}_2 = 0.0025 \times 24 = 0.0600 \text{ dm}^3$$
 [1]

- (b) The actual volume of gas collected was 50.6 cm³.

- (i) Calculate the percentage yield for this reaction. [1]

$$\% \text{ yield} = 50.6/60 \times 100\% = 84.3\%$$

(ECF given when (a) is wrong and value used correctly here)

- (ii) Besides impure reactants and human error, suggest why the yield is less than 100%. [1]

Carbon dioxide is slightly soluble in water/ Carbon dioxide reacted with water to form acid.

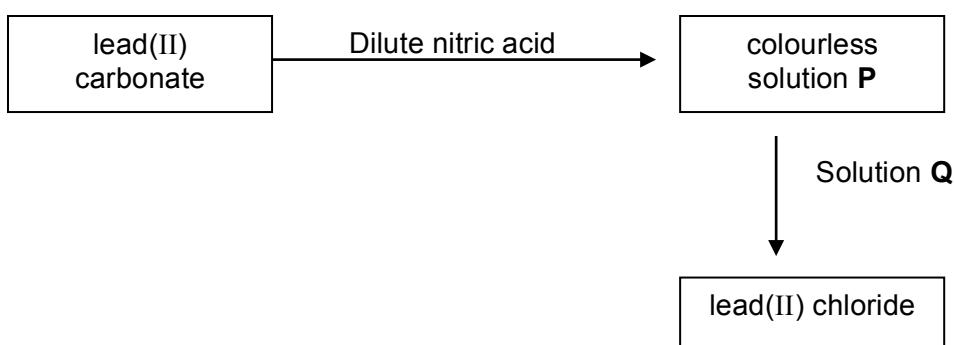
Reject: Carbon dioxide is trapped in H₂O/ escape / lost.

- (iii) Suggest a modification to the setup of this reaction to increase its percentage yield. [1]

Collect gas via downward delivery/gas syringe
Reject: Downward displacement / Change water into a liquid that dissolves CO₂

Total [7]

- B2** The reaction scheme below shows the preparation of insoluble lead(II) chloride from lead(II) carbonate.



- (a) Identify the colourless solution **P**. [1]

lead(II) nitrate (accept chemical formula or name)

- (b) Identify solution **Q**. [1]

Any soluble chloride/hydrochloric acid

- (c) Write the ionic equation for the formation of lead(II) chloride. [1]

$\text{Pb}^{2+}(\text{aq}) + 2\text{Cl}^{-}(\text{aq}) \rightarrow \text{PbCl}_2(\text{s})$

- (d) The mixture obtained was filtered, and the residue washed with distilled water. Assuming solution **Q** was added in excess to solution **P**, state the formulae of the **three** ions which were removed by washing. [2]

NO_3^{-} / cation of **Q / Cl^{-} (all 3 for 2 marks; 2 ions for 1 mark, 0/1 ions for 0 marks)**

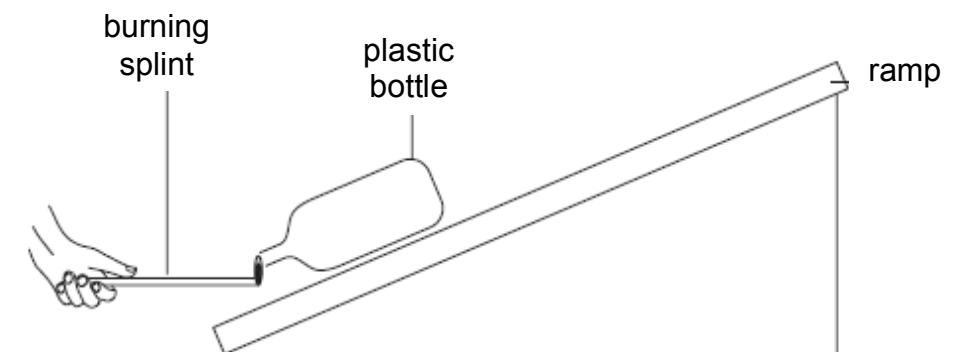
- (e) A Chemistry student from class 315 suggested that lead(II) chloride be prepared by reacting lead(II) carbonate directly with dilute hydrochloric acid. Comment on the feasibility of this method of preparation. [2]

**Yield will be low [1]
Layer of insoluble lead(II) chloride formed stops (further) reaction/the two insoluble salts cannot be separated to obtain pure salt [1]**

Total [7]

B3 Hydrogen reacts with oxygen in a reaction which produces a lot of heat energy. If a burning splint is placed near a mixture of hydrogen and oxygen, there is an explosion, and liquid water is formed.

A chemistry teacher, Mr Talran, filled a plastic bottle with different volumes of hydrogen and oxygen gases. Mr Talran placed the bottle on a sloping ramp and placed a burning splint near the open end of the bottle

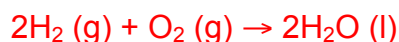


Mr Talran wanted to find the volumes of hydrogen and oxygen gases that propelled the bottle the greatest distance. The teacher repeated the experiment using the same 1 dm³ plastic bottle, but changing the volumes of hydrogen and oxygen used. The results are shown below.

volume of hydrogen gas used/ cm ³	volume of oxygen gas used/ cm ³	distance traveled by plastic bottle/ m
0	1000	0.00
200	800	3.00
400	600	4.50
600	400	5.75
800	200	4.75
1000	0	0.00

- (a) Write a balanced equation, with state symbols, for the reaction that happened.

[1]



- (b) Use the mole ratio from your equation above to deduce the simplest ratio of the masses of hydrogen, oxygen and water involved in the reaction. Show your working.

[2]

4 g of O₂ reacts with 32 g of oxygen to form 36 g of water. [1]
The mass ratio is 4:32:36 = 1:8:9 [1]

- (c) Describe the relationship between the volume of hydrogen and distance moved by plastic bottle. [2]

It increases up to 600 cm^3 / 800 cm^3 hydrogen to a maximum [1]
and then decreases to zero when the volume of hydrogen is 1000 cm^3 [1]

- (d) Explain why the plastic bottle did not move when it contained 1000 cm^3 of hydrogen. [1]

There is no oxygen for it to react with and hence no water formed. [1]

- (e) Using Avogadro's law as applied to volumes of gases, predict the volumes of hydrogen and oxygen that would make the bottle move the longest distance; write your answers to 1 decimal place. You do not necessarily have to use the combinations of volumes in the table. [1]

$666.6/7\text{ cm}^3$ of hydrogen gas and 333.3 cm^3 of oxygen gas

Total [7]

- B4** Superoxide ions, O_2^- , and hydrogen peroxide, H_2O_2 , are natural by-products of respiration in living organisms. High levels of these chemicals in cells will result in cell damage, which may lead to many forms of cancer and aging.

The superoxide ion contains an oxygen-oxygen single bond. With one unpaired electron, the superoxide ion is a highly reactive particle. Hydrogen peroxide also contains an oxygen-oxygen single bond.

- (a) Draw Lewis diagrams to show the bonding in each particle. [2]

Superoxide ion:

Hydrogen peroxide:

- (b) Construct an ionic equation to show how superoxide ions react with hydrogen ions to form molecules of hydrogen peroxide and oxygen. You may omit state symbols. [1]



- (c) Using bonding and structure, describe and explain differences in the melting points of hydrogen peroxide and potassium superoxide, KO_2 . [3]

H_2O_2 has a low melting point; KO_2 has a high melting point [1]

KO_2 has a giant ionic lattice which requires a lot of energy to overcome strong electrostatic (forces of) attraction between (oppositely-charged) ions [1]

H_2O_2 has a simple covalent structure which requires little energy to overcome weak intermolecular forces of attraction/van der Waals forces [1]

For each substance: correct structure + correct force of attraction to get 1 mark

OR

correct structure for both = 1 mark;

correct force of attraction for both = 1 mark

Total [6]

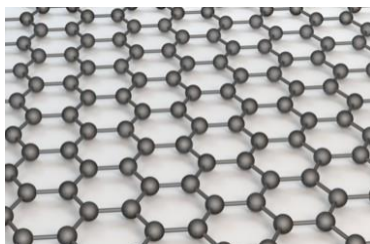
- B5** Scientists have recently developed a method to produce large sheets of a substance called graphene. Graphene is made from a single layer of graphite just one atom thick.

The properties of graphene include:

- being a good conductor of electricity;
- being transparent since it is only one atom thick;
- being strong and durable.

These properties make it suitable to use graphene to overlay a monitor screen to function as a touchscreen.

The photograph below illustrates the structure of graphene.



- (a) Suggest why graphene is a good conductor of electricity. [2]

Each carbon atom has only 3 out of 4 valence electrons used for bonding [1]

Hence there are (valence) electrons which are mobile [1]

- (b) Suggest why a sheet of graphite would not be suitable for a touchscreen. [1]

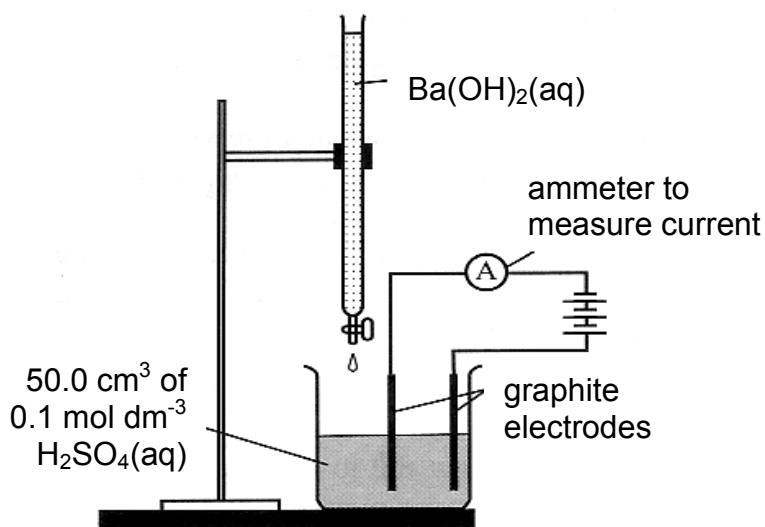
opaque (owtte) / layers of atoms slide / soft
reject "thick"

Total [3]

Section C

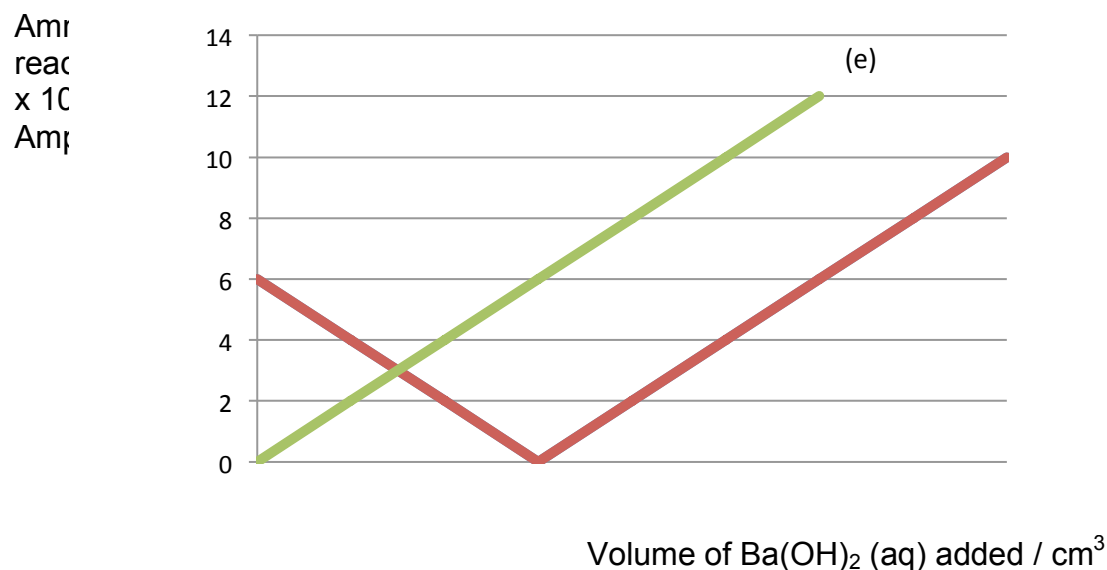
Answer **all** questions.
Write your answers in the spaces provided.

- C1** The apparatus below is used to investigate the reaction between sulfuric acid, $\text{H}_2\text{SO}_4(\text{aq})$, and barium hydroxide, $\text{Ba}(\text{OH})_2(\text{aq})$. The ammeter is acting as a simple measure of electrical conductivity, which depends on the presence of mobile ions in aqueous solution.



Aqueous barium hydroxide is added from a burette, 1 cm^3 each time, to the sulfuric acid in the beaker. After each addition, the electrical conductivity of the aqueous solution in the beaker is measured.

The graph below shows how the electrical conductivity of the solution in the beaker changes with increasing volume of barium hydroxide added.



- (a) Identify the two products of this reaction. [2]

BaSO_4 [1] and H_2O [1] – accept chemical names

- (b) State the type of reaction that occurs. [1]

Type of reaction: **neutralization/precipitation**

- (c) Use the shape of the graph to explain how the electrical conductivity of the solution in the beaker changes with the volume of barium hydroxide solution added. You may use **P**, **Q** and **R** as reference points for your explanation. [3]

The electrical conductivity decreases from P to Q and increases from Q to R. [1]

This is because the H^+ ions are removed from the acidic solution when they are neutralized by the OH^- ions /fewer or lower concentration ions in solution [1]

After Q where complete neutralization occurs, further addition of the alkali (in excess) increases the number/concentration of mobile ions in the solution [1]

- (d) Calculate the concentration of the barium hydroxide solution in mol dm^{-3} . [3]

$$n_{\text{H}_2\text{SO}_4} = 0.050 \times 0.1 = 0.00500 \text{ mol [1]}$$

$$n_{\text{Ba(OH)}_2} = 1/1 \times 0.00500 = 0.00500 \text{ mol [1]}$$

$$\text{concentration of Ba(OH)}_2 = 0.00500/0.004 = 1.25 \text{ mol/dm}^3 \text{ [1]}$$

- (e) Using the same axes on page 13, sketch the graph obtained if a similar experiment was carried out with H_2SO_4 dissolved in ethanol. Label this graph (e). [1]

Total [10]

End of paper