Class	Register Number	Name

南洋女子中學校

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)	

Section A

Answer **all** questions.
Choose the answer you consider correct and record your choice in the OAS sheet provided.

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 $C_9H_8O_4$. A typical aspirin tablet contains 325 mg of $C_9H_8O_4$. 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 mol dm^{-3} zinc nitrate?

A 0.0500 mol dm^{-3}
B 0.100 mol dm^{-3}
C 0.150 mol dm^{-3}
D 0.250 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 $C_2H_3O_2$
B $C_2H_6O_4$
C $C_4H_3O_2$
D $C_4H_6O_4$

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 H**B**. The titration method is used to prepare the salt. What are the solubilities of the carbonate, the acid and the salt?

	carbonate of **A**	acid H**B**	salt **AB**
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.

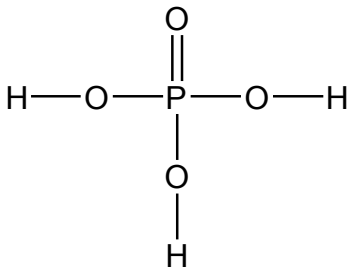
What is one product of the reaction and what is the final colour observed in the mixture?

	product	colour
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 C*l* = S – S = C*l*
B C*l* – S – S – C*l*
C S – C*l* – C*l* – S
D S – C*l* – S – C*l*

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 $Na_2C_2O_4$. Which of the following is **most** likely to be a correct chemical formula?

A $Al_3(C_2O_4)_2$
B $Ca_2C_2O_4$
C $Fe(C_2O_4)_2$
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 cm^3 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]**

(b) The actual volume of gas collected was 50.6 cm^3.

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

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

.....

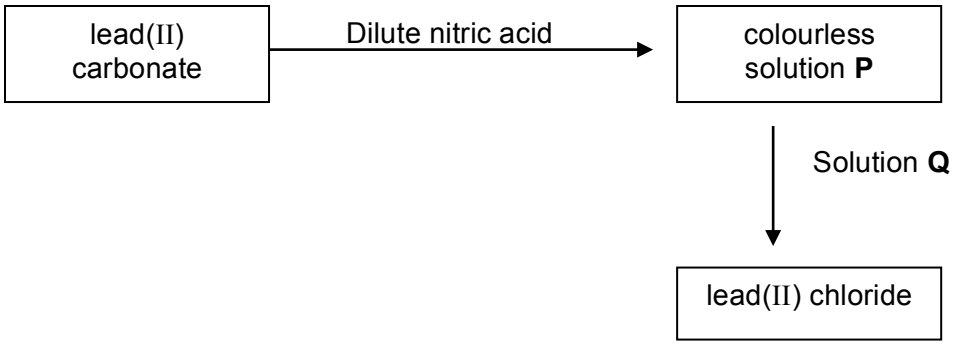
.....

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

.....

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]**

.....

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

.....

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

.....

(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]**

.....

(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]**

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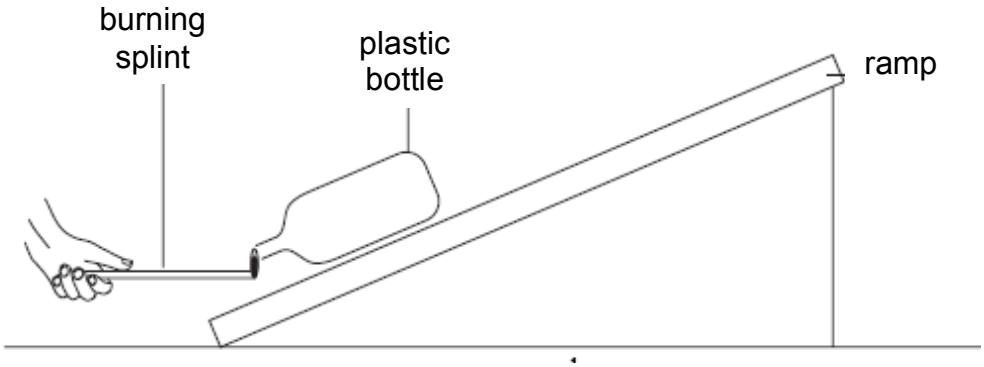
Total [7]

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 dm^3 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]**

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

……

……

……

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

…… of hydrogen gas and …… 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]**

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Total **[6]**

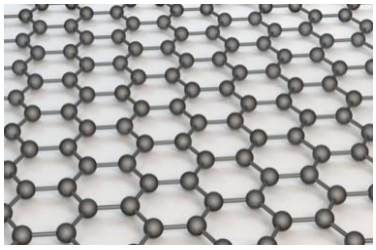
B5 Scientists have recently developed a method to produce large sheets of a substance called graphene. Graphene is made from a single layer of graphite just one atom thick.

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]**

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.....

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

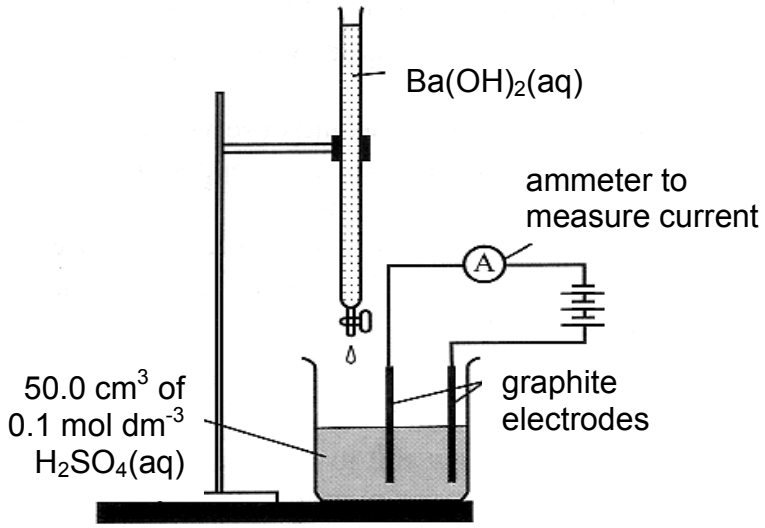
.....

Total **[3]**

Section C

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

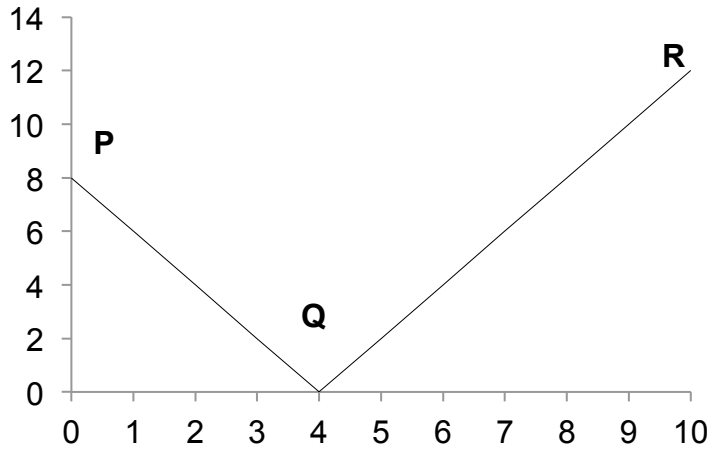
C1 The apparatus below is used to investigate the reaction between sulfuric acid, $H_2SO_4(aq)$, and barium hydroxide, $Ba(OH)_2(aq)$. The ammeter is acting as a simple measure of electrical conductivity, which depends on the presence of mobile ions in aqueous solution.



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.

Ammeter reading / x 10^{-3} Ampere



Volume of $Ba(OH)_2$ (aq) added / cm^3

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

…… and ……

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

Type of reaction: ……

(c) Use the shape of the graph to describe and 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]**

……

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……

……

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

(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]**

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Setter: MI, CT

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The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0		Key atomic number atomic symbol name relative atomic mass									5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –