Class Register No.

Candidate Name



#### PEIRCE SECONDARY SCHOOL PRELIMINARY EXAMINATION 2022 SECONDARY 4 EXPRESS / 5 NORMAL ACADEMIC

## SCIENCE (CHEMISTRY)

Paper 3 (Theory)

5076/03, 5078/03 26 AUGUST 2022 1 hour 15 minutes

Candidates answer on the Question Paper. Additional Materials: Periodic Table

## **INSTRUCTIONS TO CANDIDATES**

Write your name, class and register number on all the work you hand in. Write in dark blue or black pen. You may use a HB pencil for any diagrams or graphs. Do not use staples, paper clips, glue or correction fluid.

## Section A

Answer all questions in the spaces provided.

#### Section B

Answer **any** 2 questions. Answer **all** questions in the spaces provided. At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question. A copy of Data Sheet is printed on page **17**.

The use of an approved scientific calculator is expected, where appropriate.

	For Examiners	s' Use
	Section A	
Parent's signature	Section B	
	Total	

This paper consists of **17** printed pages and **1** blank page. Setter: Miss Pang Yin Yin

### Section A

Answer **all** questions in this section in the spaces provided. The total marks for this section is 45.

**1** A teacher used food (coloured candy) to demonstrate a science concept taught during the topic on separation technique.

He spotted the colour obtained from the sample candy onto the paper and 3 permitted food dyes (PD1, PD2, PD3) are used for comparison. He estimated the height of the solvent and placed the paper into a beaker of solvent and allowed separation to take place.

Fig. 1.1 shows the results after separation is completed.



Fig. 1.1

(a) State the separation technique demonstrated by the teacher. [1] Draw a line on Fig. 1.1 to indicate the "height of the solvent when the paper is (b) [1] placed in the beaker". Label it as (b). (C) Is the candy safe for consumption? Explain your answer. [1] ..... (d) Suggest one other use of chromatography. [1] [Total:4] **2** Fig. 2.1 shows some properties and reactions of aqueous ammonia and some other substances.





Suggest the identity of A, B, C and D.

Α	[1]
В	[1]
С	[1]
D	[1]
	[Total:4]



4



## Which one of A-F best represents

(a)	pure carbon dioxide		[1]
(b)	pure oxygen		[1]
(c)	a mixture of compounds		[1]
(d)	a mixture of elements		[1]
(e)	the products of complete combustion of hydrocarbons?		[1]
		[То	tal:5]

## **3** In Fig. 3.1, A-F represent particles in different substances.

 $\odot$ 

 $\bigcirc$ 

4 (a) Most elements occur naturally as a mixture of isotopes. For example, magnesium consists of 5 isotopes but the more stable ones are <sup>24</sup>Mg, <sup>25</sup>Mg and <sup>26</sup>Mg.

Complete the table for isotope <sup>25</sup>Mg.

Number of protons	
Number of neutrons	
Number of electrons	

[2]

- (b) All magnesium compounds have good electrical conductivity in molten states due to presence of mobile ions.
  - (i) Name the type of chemical bonding present in magnesium oxide.

[1	1
 11	

 (ii) Draw a 'dot and cross' diagram to show the arrangement of electrons in magnesium oxide in the space below. Show only valence electrons.
 [ Atomic number: Mg,12; O,8]

[2]

[Total:5]

(i) Calculate the relative molecular mass of nitric acid. [Relative atomic masses: Ar: H,1;N,14;O,16]

(ii) Calculate the concentration of the solution in mol/dm<sup>3</sup>.

Concentration: ..... mol/dm<sup>3</sup> [1]

(b) Magnesium carbonate reacts with nitric acid as follows:

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

How many moles of magnesium carbonate are needed to react with 1.0 mol of nitric acid?

Number of moles of magnesium carbonate: ..... mol [1]

[Total:3]

6 Dilute acids have many reactions with metals, carbonates and bases. For (a) example, dilute sulfuric acid reacts with calcium carbonate to form a gas, water and an insoluble salt. The same acid reacts with calcium oxide to form water and an insoluble salt. (i) Write an equation for either one of the reactions mentioned above. Include state symbols. [2] ..... (ii) Calcium sulfate can be obtained through mixing calcium nitrate and sodium sulfate solutions. Suggest how a pure dry sample of the calcium sulfate can be obtained from the reaction mixture. ..... [3] ..... (b) Sulfuric acid also participates in redox reactions. In each of these redox equations with sulfuric acid, using change in oxidation states, identify the substance being oxidised / reduced and give a reason.  $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$ (i) Substance oxidised: ..... (ii)  $C + 2H_2SO_4 \rightarrow CO_2 + 2SO_2 + 2H_2O$ Substance reduced: ..... [Total:9] 7 Table 7.1 shows the properties of some elements in Group VII.

		Table	7.1		
element	molecular formula	electronic structure	melting point / °C	boiling point / °C	radius of ion / pm
chlorine	Cl <sub>2</sub>	2.8.7	-101	-35	181
bromine	Br <sub>2</sub>	2.8.18.7	-7	59	195
iodine	l <sub>2</sub>	2.8.18.18.7	113	184	216
Х			350	610	

(1 pm = 1 x 10<sup>-12</sup> m)

(a)	Whick	h element in the table is a liquid at room temperature and pressure?	
			[1]
(b)	How	many outer shell electrons does X have?	
			[1]
(c)	Predi	ct the molecular formula of element X.	
			[1]
(d)	Estim	hate a value for the radius of $X^{-}$ ion.	
			[1]
(e)	Write	the formula of the compound when X reacts with	
	(i)	lithium,	
			[1]
	(ii)	carbon.	
			[1]
			[Total:6]

**8** Fig.8.1 represents a fractionating column where petroleum is separated into fractions.



Fig. 8.1

(a) Name the petroleum fractions X,Y and Z.

X:	Y:	
Z:		[2]

(b) One of the fractions undergoes the process of cracking to make petrol and alkenes via the reaction below:

 $C_6H_{14} \rightarrow C_4H_{10} + \ldots \ldots$ 

The above equation is incomplete. Complete the above equation by filling in the product.

[1]

- (c) After cracking, the products can be used to produce other important petrolchemical products such as plastics.
   Poly(ethene) is an example of such plastics. One poly(ethene) molecule can be made up from 500-2000 ethene molecules.
  - (i) Draw part of the structure of poly(ethene) showing at least 2 repeat units.

(ii)	Although plastics are useful to mankind, it also causes pollution problems. State a problem related to the disposal of plastics.	
		[1]

[Total:5]

[1]

**9** (a) Describe a test and give the expected results to distinguish between ethane and ethene.

		[2]
(b)	Similar to ethane and ethene, ethanol is another organic substance commonly found in the laboratory. State the reagents and conditions needed and write a chemical equation for the preparation of ethanol by fermentation.	
	Reagents and conditions:	[1]
	Chemical equation:	[1]
	[Te	otal:4]

#### Section **B**

Answer any **two** questions in this section. The total marks for this section is 20.

**10 (a)** An investigation of how a varied mass of a type of metal powder changed with time when it was placed in excess 1 mol/dm<sup>3</sup> dilute hydrochloric acid at 25.0°C.

Table 10.1 shows the results of the investigation.

			Table	10.1				
time / min	0	1	2	3	4	5	6	7
mass / g	62.0	57.2	55.4	54.2	53.2	52.4	52.0	52.0

(i) Plot a graph of mass of metal powder against time. Draw a curved line of best fit using the plotted points.

[2]



(iii) The experiment was repeated at a 35.0°C. Explain using the idea of collision theory how this will affect the rate of reaction.

12

(b) The experiment was repeated twice, with <u>one change</u> in the variable in each experiment.

Experiment	Change in variable
(i)	2.0 mol/dm <sup>3</sup> acid used, but the same volume and type of acid
(ii)	Same mass, but the use of metallic ribbon

Sketch on the graph in part (a)(i), the graphs you would expect for Experiment (i) and (ii). Label the graphs. [2]

(c) Zinc is one of the metals used in the investigation. The equation is as follows:

$$Zn + 2 HCl \rightarrow ZnCl_2 + H_2$$

Calculate the volume of hydrogen gas produced when 62.0 g of zinc reacts completely with dilute hydrochloric acid.

..... dm<sup>3</sup> [2]

[Total:10]

**11** This passage illustrates the chemistry of titanium.

Pure titanium is shiny, silver-colored and has a low density.

The world's supply of titanium metal, about 250k tons per year, is made from  $TiCl_4$ . The conversion takes place by the reduction of the chloride with magnesium metal, and yields titanium metal and magnesium chloride. This procedure is known as the Kroll process.

Unlike other metals such as iron, titanium has excellent corrosion resistance, being the ideal choice for seawater applications.

Titanium can be alloyed with different elements, such as aluminum and vanadium. The resulting alloys are commonly used in the aerospace.

One of the most used titanium alloys is Ti-A*l*-V, comprising of 80% titanium, 10% aluminium and 10% vanadium.

Passage adapted from: <u>https://www.northsteel.com/2019/02/01/titanium-and-titanium-alloys-differences-uses/</u>

(a) (i) Write an equation for the extraction of titanium using Kroll process.

.....[1]

(ii) From the equation in (a)(i), which metal is more reactive, magnesium or titanium?

......[1]

(b) With the aid of diagram, explain why Ti-A*l*-V is stronger than the added elements such as aluminium or vanadium.



(c)	From the passage, state one similar physical property between titanium and Group I elements.		
			[1]
(d)	Similar to titanium, iron is extracted by the reduction of its ore. The recycling of iron and the rust prevention is a common practice in industries.		
	(i)	Write an equation for the extraction of iron from haematite.	
			[1]
	(ii)	What is recycling of iron?	
			[1]
	(iii)	State one advantage of recycling of iron.	
			[1]
	(iv)	State one rust prevention method.	
			[1]
	[Total:1		

12 (a) Fig.12.1 shows two villages, A and B which is 100km apart.

(b)



- (c) Some of the pollutants in (a)(ii) form acid rain when they come into contact with rainwater.
  - (i) State one harmful effect to environment.
  - (ii) The acidity of acid rain is comparable to ethanoic acid.
    Give the general formula for the homologous series of carboxylic acids and use it to draw the structural formula of ethanoic acid.

general formula .....

structural formula of ethanoic acid

[2]

[Total:10]

End of paper

## DATA SHEET

# Colours of some common metal hydroxides

aluminium hydroxide	white
calcium hydroxide	white
copper(II) hydroxide	light blue
iron(II) hydroxide	green
iron(III) hydroxide	red-brown
lead(II) hydroxide	white
zinc hydroxide	white