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SCIENCE (CH	HEMISTRY)		
Secondary 4 N	Normal Academic Papers 3 a	and 4: 1 hou	ır 15 minutes
Candidates an No Additional	nswer on the Question Paper Materials are required.		
28 July 2023			
READ THESE	E INSTRUCTIONS FIRST		
Write your nar Write in dark b You may use a Do not use sta	me, class and index number on all the work you olue or black pen on both sides of the writing pa an HB pencil for any diagrams or graphs. aples, paper clips, glue or correction fluid.	u hand in. aper.	
Answer <b>all</b> que The use of an In calculations each stage. You are advise You may proce A copy of the l	estions in Section A and any <b>two</b> questions in a approved scientific calculator is expected, whe s, you should show all the steps in your work ed to spend no longer than 30 minutes on Pape eed to answer Paper 4 as soon as you have co Periodic Table is printed on page 12.	Section B. are appropria ing, giving y er 3. ompleted Pa	nte. our answer at per 3.
At the end of separately. Enter the num grid below. The number of	of the examination hand in your answers to nbers of Section B questions you have answere of marks is given in brackets [ ] at the end	o Paper 3 ed on the dot of each qu	and Paper 4 tted line in the estion or part
	NOT OPEN THIS PAPER LINTH YOU ARE T		50
		or Examine	r's Use
	S	ection A	
	S 	ection B	
	Т	otal	30
	This document consists of 12 printed pages, including the	ne cover page.	

## **Section A**

Answer **all** the questions in the spaces provided.

A1 The diagrams below represent the particles of six different substances at room temperature and pressure.



Complete the table below to show which diagrams, A to F, best represent each of the following descriptions.

You may use each letter once, more than once or not at all.

Substance	Diagram
(a) Water	
(b) Oxygen gas	
(c) Mercury	
(d) Mixture	
	[4]

[Total:4]

A2 In Singapore, it is an offence for the driver of a motor vehicle to leave the engine of a vehicle idling while it is stationary. This measure is implemented to control the emissions generated by motor vehicles and safeguard public health.

Nitrogen monoxide and carbon monoxide are the most polluting emissions from vehicle combustion engines. The concentration of each of these components depends on the mode of operation and the air-fuel ratio of the vehicle.

scenario	mode of operation	air-fuel ratio	concentration of NO/ppm	concentration of CO/ppm
1	idling engine	12:1	10	8500
2	idling engine	15:1	14	4500
3	accelerating	12:1	1000	5000
4	accelerating	15:1	3700	1000

The table below shows some information on these pollutants.

(a) Using the information from the table,

(i) state the relationship between the air-fuel ratio and the concentration of CO emitted.

.....

- .....[1]
- (ii) suggest why the concentration of NO is higher in accelerating mode, which has higher temperature, as compared to idling mode.

.....[1]

(b) Name the type of chemical reaction that occurs when fuels are burnt in limited supply of air.

.....[1]

(c) Briefly describe how NO and CO can affect the public health.

......[2] [Total: 5]

[Turn over

For Examiner's Use A3 The diagram below shows how an organic compound pentadecane, C<sub>15</sub>H<sub>32</sub>, breaks down in the presence of aluminium oxide.



## **Section B**

Answer any **two** questions in the spaces provided.

**B4** The table below shows the reactions of alkali metals (lithium, sodium and potassium)

metal	reaction with oxygen
lithium	burns quickly with a red flame to give a white solid residue
sodium	burns very quickly with a bright yellow flame to give a white solid residue
potassium	burns violently with a lilac flame to give a white solid residue

(a) Using **M** as the symbol to represent an alkali metal, write a general equation for the reaction between an alkali metal and oxygen.

......[1]

(b) Using the information from the table, state the trend in the reactivity of the alkali metals towards oxygen.

......[1]

(c) The reactivity of the alkali metals towards water is similar to that of alkali metals towards oxygen. Rubidium is placed below potassium in the Periodic Table. Suggest one possible observation when rubidium reacts with water.

......[1]

(d) The relative atomic masses and the melting points of the alkali metals are given below.

metal	relative atomic mass	melting point/°C
lithium	7	181
sodium	23	98
potassium	39	?
rubidium	85	39

- (i) Plot a graph of melting point against relative atomic mass, marking each point with a cross (X). [1]
- (ii) Draw a curved line of best fit, taking into account all your plotted points. [1]

For Examiner's Use melting point/°C relative atomic mass (iii)Using the graph, predict the melting point of potassium,

melting point of potassium = .....°C [1]

[Turn over

- (e) Metal scrap is one of the largest types of waste generated in Singapore. Therefore, ferrous metal (iron and steel) is usually sent to a local steel mill for recycling. This can be done by adding it to a blast furnace.
  - (i) Suggest a reason why we should recycle ferrous metal.

.....[1]

(ii) Draw a labelled diagram to show how specific atoms are arranged in steel which is made up of iron and carbon.





For Examiner's Use **B5** Alice took a sample of soil from the school garden and mixed it with water. She then filtered the mixture and measured the pH value of the filtrate. 2cm<sup>3</sup> of sodium hydroxide was then added to the filtrate. The pH value was then tested.

The process was repeated, adding 2cm<sup>3</sup> of sodium hydroxide each time to the filtrate until 20cm<sup>3</sup> of sodium hydroxide was added.

The data is shown below.

volume of sodium hydroxide added to the filtrate/cm <sup>3</sup>	resulting pH value
2	4
4	4
6	4
8	6
10	8
12	10
14	12
16	14
18	14
20	14

- (a) Plot a graph of volume of sodium hydroxide added against resulting pH value, marking each point with a cross (X).
- (b) Draw the graph by joining all your plotted points using straight lines.

pН Volume of sodium hydroxide added/ cm<sup>3</sup>

[Turn over

[1]

(c) Using your graph, predict the volume of sodium hydroxide needed to neutralize the Examiner's Use filtrate. volume of sodium hydroxide needed =  $\dots cm^{3}$  [1] (d) A few drops of Universal Indicator is added to the final mixture at the end of the experiment. State the colour that will be observed. .....[1] (e) Sulfur dioxide is an air pollutant that can dissolve in water to form sulfuric acid, H<sub>2</sub>SO<sub>4</sub>. This can result in acid rain which affects the acidity of the soil and impacts agriculture. To reduce the acidity of the soil, liming materials are used. An example of a liming material is calcium carbonate, CaCO<sub>3</sub>. (i) Write a balanced chemical equation for the reaction between sulfuric acid and calcium carbonate. (ii) Besides affecting agriculture, state two other effects of acid rain. ..... ..... ......[2] (iii)Suggest another liming material that can be used to reduce the acidity of the soil. [Total: 8]

**B6** Petroleum is a mixture of hydrocarbons that can be separated by fractional distillation.

The diagrams below show the percentage of different fractions obtained when petroleum is distilled (diagram A) and the percentage use of different fractions (diagram B).



For

Examiner's Use (iii)State one chemical test that can be used to differentiate between propane and propene. State the expected observations.

Chemical Test:
[1]

Observation with propane:
[1]

Observation with propene:
[1]

[1]
[1]

[1]
[1]

[1]
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0	2	Ч	helium	4	10	Ne	neon	20	18	Ar	argon 40	36	Ł	krypton	84	54	×	xenon	131	86	Ł	radon	I				
VII					6	ш	fluorine	19	17	C1	chlorine 35.5	35	Ъ	bromine	80	53	Ι	iodine	127	85	At	astatine	1				
VI					8	0	oxygen	16	16	თ	sulfur 32	34	Se	selenium	79	52	Те	tellurium	128	84	Ъ	polonium	1	116	2	livermorium	I
>					7	z	nitrogen	14	15	٩	phosphorus 31	33	As	arsenic	75	51	Sb	antimony	122	83	ï	bismuth	209			_	
N					9	o	carbon	12	14	<u>S</u>	silicon 28	32	9 0	germanium	73	50	S	tin	119	82	Ър	lead	207	114	F/	flerovium	I
					5	ш	boron	11	13	A1	aluminium 27	31	Ga	gallium	70	49	Ŀ	indium	115	81	Tl	thallium	204				
				·								30	Zn	zinc	65	48	පී	cadmium	112	80	ĥ	mercury	201	112	C	copernicium	I
												29	Cu	copper	64	47	Ag	silver	108	79	Au	gold	197	111	Rg	roentgenium	I
												28	ïZ	nickel	59	46	Р	palladium	106	78	ځ	platinum	195	110	Ds	darmstadtium	I
												27	ပိ	cobalt	59	45	RЪ	rhodium	103	17	Ir	iridium	192	109	Mt	meitnerium	I
	<u>_</u>	т	hydrogen	-								26	Fе	iron	56	44	Ru	ruthenium	101	76	0s	osmium	190	108	Hs	hassium	I
												25	Mn	manganese	55	43	۲	technetium	I	75	Re	rhenium	186	107	Bh	bohrium	I
					umber			mass				24	റ്	chromium	52	42	٩	molybdenum	96	74	≥	tungsten	184	106	Sg	seaborgium	I
			2	Key	(atomic) n	mic symt	name	ve atomic i				23	>	vanadium	51	41	qN	niobium	93	73	Ta	tantalum	181	105	Db	dubnium	I
					proton	atc		relativ				22	F	titanium	48	40	Zr	zirconium	91	72	Ŧ	hafnium	178	104	Ł	Rutherfordium	I
				•					-			21	ပ္ပ	scandium	45	39	≻	yttrium	89	57 - 71	lanthanoids			89 - 103	actinoids		
=					4	Be	beryllium	6	12	Mg	magnesium 24	20	Ca	calcium	40	38	പ്	strontium	88	56	Ba	barium	137	88	Ra	radium	I
_					e e	:	lithium	7	11	Na	sodium 23	19	¥	potassium	39	37	<del>8</del>	rubidium	85	55	ട്	caesium	133	87	ц	francium	I
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	La	0 C	ď	PN	Рш	Sm	Eu	B	Ъ	Q	ቶ	ш	Tm	٩۲	Ц
	lanthanum	cerium	praseodymium	neodymium	promethium	samarium	europium	gadolinium	terbium	dysprosium	holmium	erbium	thulium	ytterbium	lutetium
	139	C	141	144	I	150	152	157	159	163	165	167	169	173	175
actinoids	89	_	91	92	93	94	95	96	97	86	66	100	101	102	103
	Ac	-	Pa		dN	Ъ	Am	с С	푎	പ്	ů	ш	РМ	٩	۲
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	I	~	231	238	I	I	I	I	I	I	I	I	I	I	I

The volume of one mole of any gas

 $\ensuremath{\mathfrak{n}}^3$  at room temperature and pressure (r.t.p.).

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