2023 SECONDARY 3
CLASS TEST 2

CHEMISTRY

18 August 2023 (Friday) **50 minutes**

CANDIDATE NAME			
CLASS		INDEX NUMBER	

READ THESE INSTRUCTIONS FIRST
Do not turn over the page until you are told to do so.
Write your name, class, and index number in the spaces provided above.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
There are **ten** questions in this section. 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 table on Page 2.

Sections B
Answer **all** the questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets [ ] at the end of each question or part question.

The total mark for this paper is **40**.

Approved electronic calculators are allowed for use in this paper.

A copy of the Periodic Table is printed on page 11.

For Examiner's Use	
Section A	
Section B	
Total	40

This document consists of **11** printed pages including the cover page.

[Turn over

Section A

Write your answers clearly in the table below.

Question	1	2	3	4	5	6	7	8	9	10
Answer										

1 Element P has a lattice of positive ions and a 'sea of electrons'.

Which statement describes P?

A It conducts electricity by the movement of ions and electrons.
B It is not malleable.
C It is decomposed by an electric current.
D It requires a large amount of heat to change its state from solid to liquid.

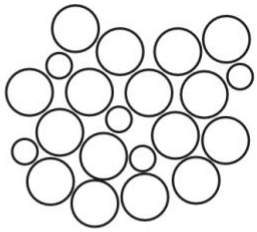
2 Nitrogen crystals are obtained by freezing nitrogen at -196 ^{o}C.

What will the nitrogen crystals contain?

A nitrogen atoms only
B nitrogen molecules only
C nitrogen atoms and molecules
D nitrogen ions and nitrogen atoms

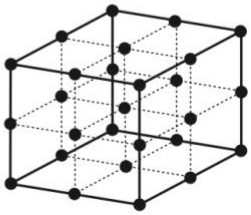
3 Which diagram shows the structure of graphite?

A

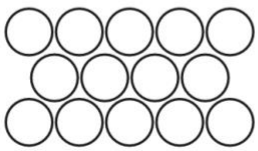


B

C



D



[Turn over

4 Sulfur forms compounds with the elements hydrogen, oxygen and magnesium. These compounds have the formulae X_2S, YS and SZ_2, where S represents sulfur.

What are the identities of X, Y and Z?

	H	O	Mg
A	Z	X	Y
B	Y	X	Z
C	X	Z	Y
D	Z	Y	X

5 The Avogadro constant is the number of

A atoms in 24 g of magnesium.
B atoms in 28 g of helium.
C chloride ions in 95 g of magnesium chloride.
D molecules in 35.5 g of chlorine.

6 Silver ions react with chloride ions as shown in the ionic equation below.

$$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$$

It is found that 5 cm^3 of a 0.1 mol/dm^3 solution of the chloride of metal Q needs 10 cm^3 of 0.1 mol/dm^3 silver nitrate for complete reaction.

What is the formula of the chloride of metal Q?

A QCl_4
B Q_2Cl
C QCl
D QCl_2

7 On adding 50 g of impure limestone, $CaCO_3$ (M_r = 100), to excess hydrochloric acid, 6.0 dm^3 of CO_2 was evolved at room temperature and pressure.

What is the purity of the limestone?

A 25%
B 50%
C 75%
D 100%

8 Which one of the following is the ionic equation for the reaction between magnesium and hydrochloric acid?

A $Mg(s) + 2H^+(aq) \longrightarrow Mg^{2+}(aq) + H_2(g)$
B $Mg(s) + H^+(aq) \longrightarrow Mg^+(aq) + H(g)$
C $Mg^{2+}(s) + 2H^+(aq) \longrightarrow Mg^{2+}(aq) + 2H(g)$
D $Mg(s) + 2H(aq) \longrightarrow Mg(aq) + 2H(g)$

[Turn over

9 The colour of an indicator in solutions of different pH is shown below.

pH	0	2	4	6	8	10	12	14
colour	red	orange	yellow					

Which two solutions can be distinguished using the indicator?

A aqueous ammonia and aqueous sodium hydroxide
B aqueous hydrogen chloride and aqueous carbon dioxide gas
C aqueous sodium hydroxide and aqueous sodium chloride
D aqueous sodium chloride and water

10 Waste water from a factory was found to have a pH of 2.

Which substance could be used to neutralise the waste water before it is released into a river?

A calcium hydroxide
B calcium sulfate
C sodium chloride
D sulfur dioxide

[Turn over

Section B

Answer **all** questions.

Write your answers in the spaces provided.

1 Name an element from Period 3, sodium to argon, that matches the description for each of the following. You may use each element once, more than once, or not at all.

(a) It forms an insoluble basic oxide.

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(b) It forms a substance that has a giant molecular structure with oxygen.

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(c) It reacts with oxygen to form a gas that turns damp blue litmus paper red.

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(d) It forms an ion by gaining three electrons.

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(e) It forms a covalent compound with nitrogen. The ratio of the number of atoms of the element and nitrogen is 3:1 in the covalent compound.

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[Total: 5 marks]

2 Chlorofluorocarbons (CFCs) are compounds that contain only carbon, chlorine and fluorine. They are atmospheric pollutants and destroy ozone in the upper atmosphere.

(a) 'CFC11' has the following composition by mass:

C : 8.7% , F : 13.8% , C*l* : 77.5%

Calculate and state the empirical formula of 'CFC11'. [3]

(b) 'CFC12' has the molecular formula CF_2Cl_2. 'CFC12' can be made by the reaction of hydrogen fluoride, HF, with tetrachloromethane, CCl_4, forming hydrogen chloride as a by-product.

(i) Draw the 'dot-and-cross' diagram of 'CFC12'. Show valence electrons only.[2]

(ii) Write a balanced chemical equation to show the formation of 'CFC12'. [1]

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(iii) 10.0 g of hydrogen fluoride and 36.0 dm^3 of tetrachloromethane gas were reacted to produce 'CFC12'.

Determine the limiting reagent for this reaction. Hence, calculate the maximum mass of 'CFC12' that can be produced. [4]

[Total:10 marks]

3 Potassium sulfate can be prepared from the reaction between aqueous potassium hydroxide and dilute sulfuric acid.

(a) Describe how a solution of potassium sulfate can be prepared using the reagents provided. [4]

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(b) Explain why it is not recommended to use potassium carbonate and dilute sulfuric acid to prepare potassium sulfate using the method in **3(a)**. [1]

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[Total: 5 marks]

4 Chemical substances and their physical properties

Chemical substances have different physical properties based on its structure and chemical bonding. If the substance is insoluble in water, the electrical conductivity in its aqueous state was not tested.

Table 4.1 gives information on the physical properties of some chemical substances.

Table 4.1

chemical substance	melting point / °C	boiling point / °C	electrical conductivity in solid state	electrical conductivity in liquid state	electrical conductivity in aqueous state
A	1085	2562	good	good	-
B	650	1091	good	good	-
C	3550	4830	poor	poor	-
D	851	1600	poor	good	good
E	811	1450	poor	good	-
F	-126	97	poor	poor	-

Acids and pH

Solutions of different acids of the same concentration (in mol/dm^3) have different properties. The concentration of hydrogen ions, the pH and the reaction with chemical substances may be different, even when the initial concentration of the acid is the same.

Table 4.2 gives information on the solutions of acids at different concentrations.

Table 4.2

name of acid	concentration of acid in mol / dm^3	concentration of hydrogen ions in solution in mol / dm^3	pH
nitric acid	0.01	0.01	2.0
	0.10	0.10	1.0
	0.20	0.20	0.7
sulfuric acid	0.01	0.02	1.7
	0.02	0.04	1.4
ethanoic acid	0.01	0.0004	3.4
	0.05	0.0009	3.0
	0.10	0.0013	2.9
nitrous acid	0.01	4.50×10^{-6}	5.4
	0.05	0.005	2.3
	0.10	0.007	2.0

[Turn over

Reactions of Acids with Chemical Substances

Excess of each of the chemical substances were reacted separately with 25 cm^3 dilute nitric acid and sulfuric acid of concentration 0.01 mol/dm^3. The total volume of gas was recorded at the end of the reaction.

Table 4.3 gives information of the chemical reaction between the acids and the chemical substances.

Table 4.3

chemical substances	total volume of gas produced when reacted with	
	dilute nitric acid / cm^3	dilute sulfuric acid / cm^3
A	0.0	0.0
B	10.0	20.0
C	0.0	0.0
D	10.0	20.0
E	10.0	4.0
F	0.0	0.0

(a) With reference to the information from Table 4.1, determine the structures of C and F. Explain your reasoning based on the information provided. [2]

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(b) With reference to the information from Table 4.2, explain why the concentration of hydrogen ions in 0.01 mol/dm^3 of nitric acid and nitrous acid is different. [2]

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(c) A and B are both metals.

(i) With reference to the information from Table 4.3, state and explain one factor that affect the total volume of gas produced when these chemical substances reacted with both nitric and sulfuric acid. [2]

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(ii) With reference to the information from Table 4.3, suggest the total volume of gas produced when B reacts with 25 cm^3 of 0.01 mol/dm^3 of ethanoic acid. Explain your answer. [2]

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(d) The type of bonding in D and E is similar. D and E react with both dilute nitric acid and sulfuric acid to produce gases of different volumes.

Suggest a reason for the difference in the volume of gas produced when D reacts with sulfuric acid compared to E. [2]

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[Total: 10 marks]

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	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 –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).
The Avogadro constant, L = 6.02 u 10^{23} mol^{-1}.