



Paya Lebar Methodist Girls' School (Secondary)
End of Year Examination 2023
Secondary 3 Express

CANDIDATE NAME		CLASS		CLASS INDEX NUMBER	
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CHEMISTRY

Modified 6092/01

Paper 1 Multiple Choice

4 October 2023

Additional Materials: Multiple Choice Answer Sheet

45 minutes

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name and class index number on the separate Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. 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 **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 2.

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

This paper consists of 14 printed pages, including this cover page.

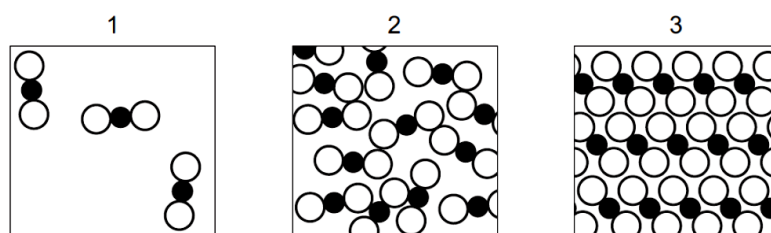
[Turn over

- 1 “Particles moving **very slowly** from an area of higher concentration to an area of lower concentration.”

Which process is being described?

- A a liquid freezing
- B a solid melting
- C a substance diffusing through a liquid
- D a substance diffusing through a gas

- 2 Diagrams of the three states of matter for carbon dioxide are shown below.



Which two diagrams show the states of matter before and after the sublimation of carbon dioxide?

- A 2 to 1
- B 3 to 1
- C 2 to 3
- D 3 to 2

- 3 The table shows information about four different particles.

particle	proton number	nucleon number	number of protons	number of neutrons	number of electrons
Na	11	23	11	W	11
Na ⁺	11	23	11	12	X
O	8	16	8	Y	8
O ²⁻	8	16	8	8	Z

What are the values of W, X, Y and Z?

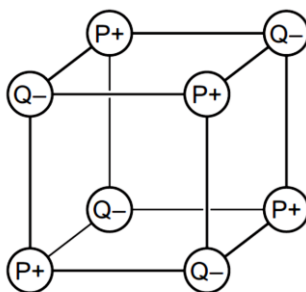
	W	X	Y	Z
A	11	10	10	8
B	11	11	8	10
C	12	10	8	10
D	12	11	10	8

- 4 An atom of one isotope of bromine is represented by the symbol ${}^{81}_{35}\text{Br}$.

Which row is correct for an atom of a **different** isotope of bromine?

	number of neutrons	number of protons	nucleon number
A	44	35	44
B	79	44	79
C	44	35	79
D	47	35	82

- 5 Two elements, P and Q are in the same period of the Periodic Table.
P and Q react together to form an ionic compound. Part of the lattice of this compound is shown.



Which statement is correct?

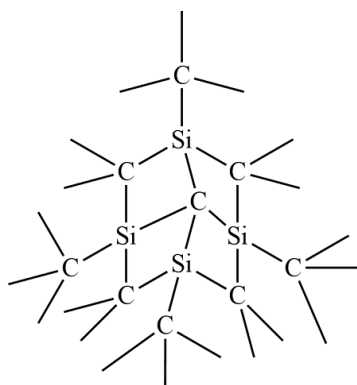
- A** An ion of P has more electrons than an ion of Q.
B P is to the left of Q in the Periodic Table.
C Element P is non-metallic.
D The formula of the compound is P_4Q_4 .
- 6 Iron is a metal. Its structure consists of a giant lattice of positive ions in a 'sea of electrons'.

Which statements about solid iron are correct?

- 1 Iron conducts electricity because the electrons are free to move.
- 2 Iron conducts heat because the positive metal ions are free to move.
- 3 Iron has a high melting point due to the strong ionic bonds.
- 4 Iron is malleable because the layers of atoms can slide over one another.

- A** 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 1, 2 and 4

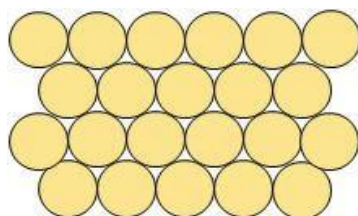
- 7 The diagram shows the structure of silicon carbide, a compound of carbon and silicon.



Which are the most likely properties of silicon carbide?

	melting point/ $^{\circ}\text{C}$	boiling point/ $^{\circ}\text{C}$	soluble in water	conducts electricity
A	- 120	- 60	yes	no
B	560	988	no	yes
C	875	1242	yes	no
D	1623	2475	no	no

- 8 The arrangement of atoms in pure copper is shown below.

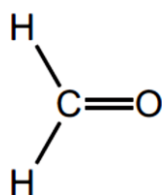


Brass can be made by adding zinc to pure copper.

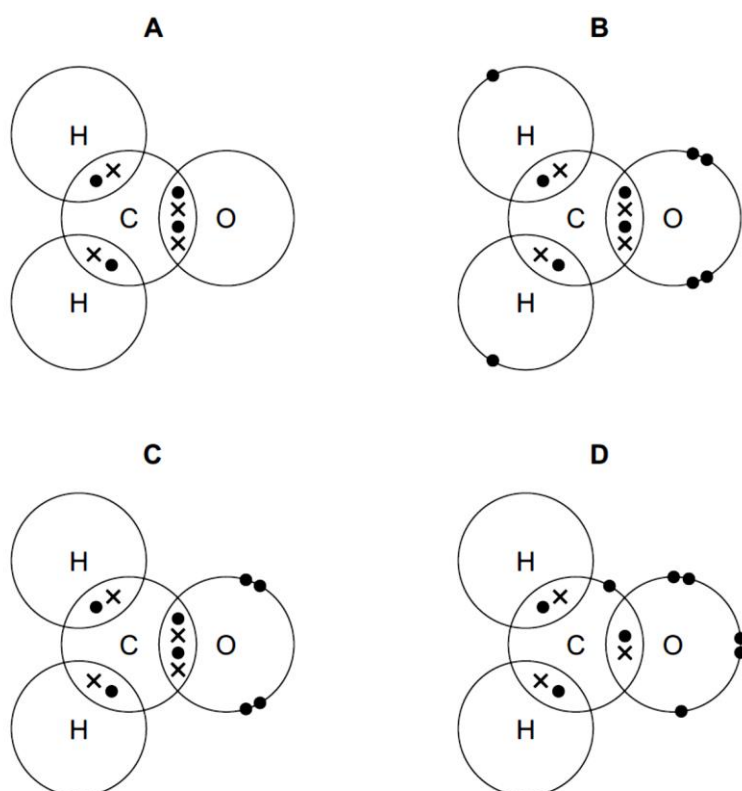
Which description of the arrangement of atoms in brass is correct?

- A** A regular pattern of copper atoms with zinc atoms fitting into one corner.
- B** A regular pattern of zinc atoms with copper atoms fitting into the gaps between them.
- C** Rows of copper atoms alternating with rows of zinc atoms.
- D** An irregular pattern of zinc atoms and copper atoms randomly spread throughout the structure.

9 The structure of methanal is shown below.



Which diagram shows the arrangement of outer shell electrons in a molecule of methanal?



10 A student measures the time taken to react 2 g of magnesium with 50 cm³ of sulfuric acid.

Which apparatus is essential to complete the experiment?

- 1 stopwatch
- 2 thermometer
- 3 measuring cylinder
- 4 electronic balance

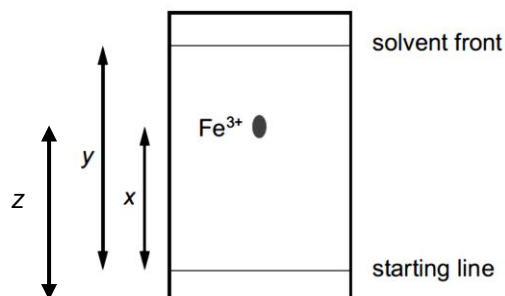
A 1, 3 and 4

B 1, 2 and 4

C 3 and 4

D 1 and 3

- 11** A paper chromatography experiment is carried out to find an R_f value for $\text{Fe}^{3+}(\text{aq})$. The result is shown below.



To make the spot containing $\text{Fe}^{3+}(\text{aq})$ more visible, the spot is sprayed with aqueous sodium hydroxide so that a precipitate of iron (III) hydroxide forms.

Under the conditions of the experiment, the R_f of $\text{Fe}^{3+}(\text{aq})$ is given by1... and the colour of the precipitate is ...2...

Which row correctly completes 1 and 2?

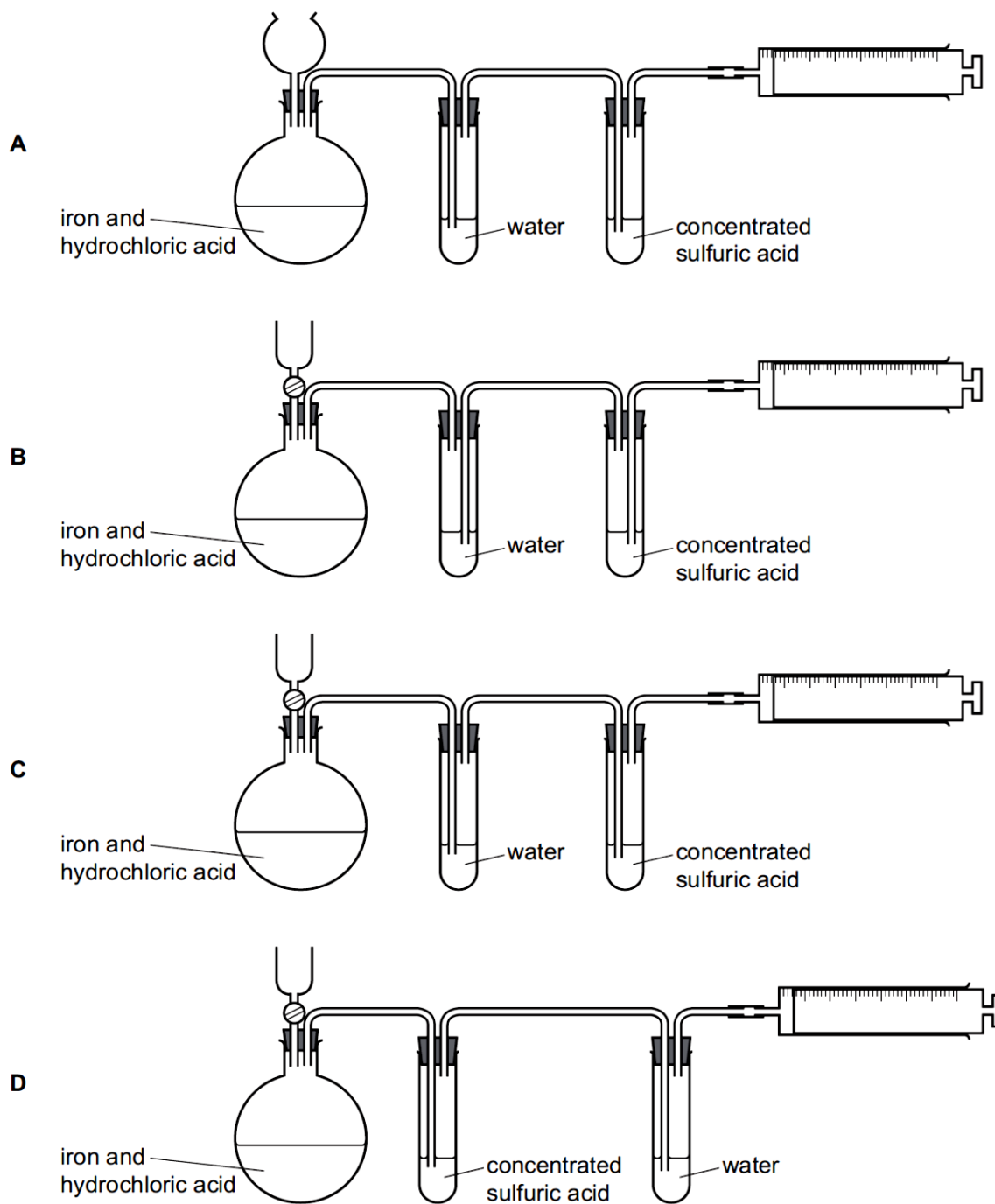
	1	2
A	$\frac{x}{y}$	green
B	$\frac{z}{y}$	red-brown
C	$\frac{y}{x}$	green
D	$\frac{x}{y}$	red-brown

- 12** Which sequence of procedures is used to separate a pure, dry sample of hydrated copper (II) sulfate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, from a mixture containing hydrated copper (II) sulfate and calcium carbonate, CaCO_3 ?

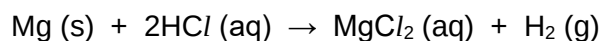
- A** dissolve in water → filtration → evaporation to dryness
- B** dissolve in water → filtration → crystallisation
- C** distillation → crystallisation → heating to remove all water
- D** fractional distillation → filtration → heating to remove all water

- 13** When iron reacts with dilute hydrochloric acid, hydrogen is formed. Due to the presence of impurities in the iron, some hydrogen sulfide gas is also formed. Hydrogen sulfide gas is soluble in water. Water vapour can be removed from a mixture of gases using concentrated sulfuric acid.

Which diagram shows the apparatus suitable to prepare a pure, dry sample of hydrogen?



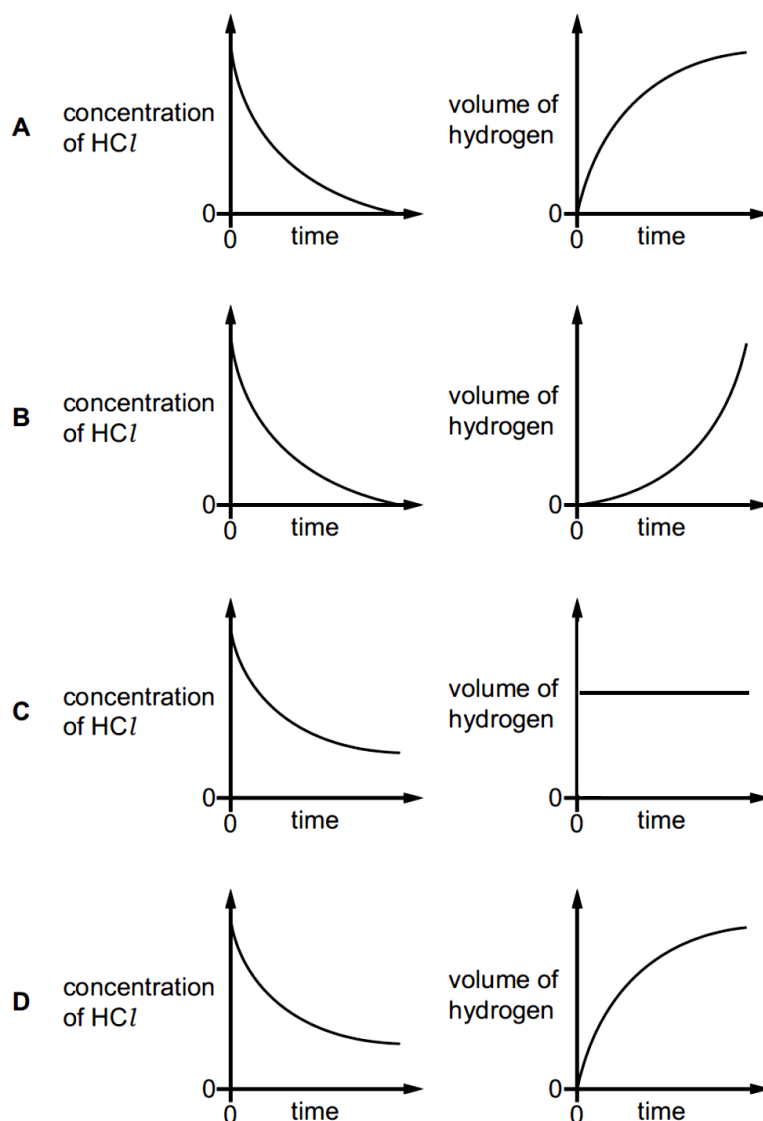
- 14 The rate of reaction between magnesium and dilute hydrochloric acid is investigated. The equation is shown.



A known mass of magnesium is added to an excess of dilute hydrochloric acid.

The concentration of the hydrochloric acid and the volume of hydrogen produced is measured at regular time intervals.

Which pair of graphs correctly shows the experimental results?



15 Which statement about acids and bases is correct?

- A** A 0.1 mol/dm^3 solution of ethanoic acid has a higher pH than a 0.1 mol/dm^3 solution of hydrochloric acid.
- B** All bases dissolve in water to produce OH^- ions.
- C** All bases react with nitrates to produce ammonia.
- D** Oxides of metals are always acidic in character.

16 Which substance reacts with dilute sulfuric acid in the preparation of a pure sample of lead (II) sulfate?

- A** lead foil
- B** powdered lead (II) carbonate
- C** powdered lead (II) oxide
- D** aqueous lead (II) nitrate

17 Two solutions are prepared.

Solution P is 0.0500 mol/dm^3 hydrochloric acid.

Solution Q is 0.0500 mol/dm^3 butanoic acid.

A 2 cm strip of magnesium is added into 100 cm^3 of each solution. Fizzing is seen in both solutions but the fizzing is faster in solution P than it is in solution Q.

Which statement helps to explain this observation?

- A** Magnesium reacts with solution P to form a salt but does not form a salt with solution Q.
- B** More acid particles are dissociated in solution P than are dissociated in solution Q.
- C** Solution Q contains a stronger acid than solution P.
- D** The particles are closer together in solution Q than they are in solution P.

18 Tin oxide is an amphoteric oxide.

Which reagent can be used to distinguish between tin oxide from calcium oxide?

- 1 $\text{HNO}_3 (\text{aq})$
- 2 $\text{HCl} (\text{aq})$
- 3 $\text{NH}_3 (\text{aq})$
- 4 $\text{NaOH} (\text{aq})$

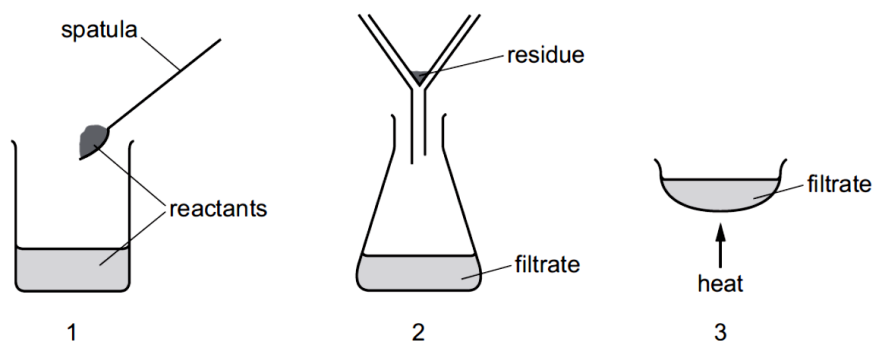
A 1 or 2

B 1 or 3

C 2 or 4

D 3 or 4

19 The diagrams show three stages, 1, 2 and 3, used in the preparation of a salt.



Which row correctly shows the reactants that can be used to prepare the salt?

	reactants	salt
A	copper and nitric acid	copper (II) nitrate
B	sodium and sulfuric acid	sodium sulfate
C	iron (II) carbonate and hydrochloric acid	iron (II) chloride
D	barium hydroxide and sulfuric acid	barium sulfate

20 An aqueous solution contains a salt, Y.

Addition of an aqueous solution X results in a precipitate being formed that redissolves when more X is added.

What could solution X and salt Y be?

	solution X	salt Y
A	HCl(aq)	AgNO ₃
B	H ₂ SO ₄ (aq)	Ba(NO ₃) ₂
C	NaOH(aq)	CuSO ₄
D	NaOH(aq)	ZnSO ₄

21 The following tests were conducted on compound T.

test	observation
add sulfuric acid	white precipitate
add sodium hydroxide, followed by aluminium foil and warm	gas that turns moist red litmus paper blue produced

What is the identity of compound T?

- A calcium sulfate
- B sodium chloride
- C barium nitrate
- D ammonium nitrate

22 The following substances are used in the laboratory to test for various ions and gases.

aqueous ammonia	aqueous barium nitrate	wooden splint
red litmus paper	limewater	blue litmus paper

When testing for ammonia, chlorine, hydrogen and oxygen, what is the **minimum** number of items from the table above needed to identify these four gases?

- A 2
- B 3
- C 4
- D 5

23 Below are five substances.

Symbol for substance	Substance
P	hydrochloric acid
Q	aqueous silver nitrate
R	aqueous barium chloride
S	aqueous ammonium sulfate
T	aqueous sodium hydroxide

Which combination of substances will give the observations below?

	a precipitate is formed	a gas is produced
A	P and T	R and S
B	Q and R	S and T
C	R and S	P and R
D	P and Q	Q and T

- 24** Sodium hydrogencarbonate decomposes on heating.



In an experiment, 5.0 mol of sodium hydrogencarbonate was heated.

What is the volume of carbon dioxide evolved, at room temperature and pressure?

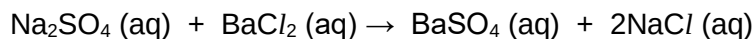
- A** 24 dm³ **B** 36 dm³ **C** 48 dm³ **D** 60 dm³

- 25** The atomic number of ruthenium is 44. One of the oxides of ruthenium is a black solid, X. 5.79 g of X contains 1.39 g of oxygen.

What is the empirical formula of X?

- A** Ru₂O₃ **B** RuO **C** RuO₂ **D** Ru₂O

- 26** When excess aqueous barium chloride is added to 25.0 cm³ of 1.00 mol/dm³ sodium sulfate, a white precipitate of barium sulfate is formed.



The precipitate is filtered off, washed, dried and weighed. 5.36 g barium sulfate is obtained.

What is the percentage yield of barium sulfate?

[Mr: Na₂SO₄, 142; BaCl₂, 208; BaSO₄, 233; NaCl, 58.8]

- A** 2.3 % **B** 27 % **C** 92 % **D** 97 %

- 27** Which contains the greatest mass of solute?

- A** 100 cm³ of 1.00 mol/dm³ sodium hydroxide, NaOH
B 500 cm³ of 0.05 mol/dm³ sulfuric acid, H₂SO₄
C 1.00 dm³ of 0.10 mol/dm³ potassium hydroxide, KOH
D 2.00 dm³ of 0.01 mol/dm³ hydrochloric acid, HCl

28 The relative formula masses of four compounds are given.

A student has a 1.0 g sample of each compound.

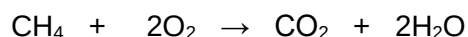
Which sample contains the highest number of moles of oxygen atoms?

	compound	relative formula mass
A	Al_2O_3	102
B	CuO	80
C	H_2SO_4	98
D	HNO_3	63

29 A mixture of 5 cm³ of methane gas, CH_4 and 100 cm³ of oxygen is exploded.

The resulting mixture is cooled.

The chemical equation for the reaction is shown below.



What is the volume of gases remaining at room temperature and pressure?

- A** 95 cm³ **B** 90 cm³ **C** 25 cm³ **D** 15 cm³

30 Powdered calcium carbonate reacts with dilute hydrochloric acid to produce calcium chloride.

What is the correct ionic equation, including state symbols, for this reaction?

- A** $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
B $\text{Ca}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
C $\text{CO}_3^{2-}(\text{aq}) + 2\text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
D $\text{CaCO}_3(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Ca}^{2+}(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$

END OF PAPER

Answers to Sec 3 Pure Chem EOY P1 2023

Qn	Ans	Explanation
1	C	Movement of particles from a region of higher concentration to a region of lower concentration is diffusion. "Very slowly" indicates diffusion occurring in a liquid and not a gas as gas particles have high energy and move rapidly.
2	B	Sublimation is a change in state from solid to gas.
3	C	Na: $23 - 11 = 12$ neutrons (W) ; Na^+ : lost 1 electron, $11 - 1 = 10$ electrons (X) O: $16 - 8 = 8$ neutrons (Y) ; O^{2-} : $8 + 2 = 10$ electrons (Z)
4	D / C	No of protons = 35 (atomic number); No of neutrons = $81 - 35 = 46$
5	B	P is a metal as it forms + ion. Q is a non-metal as it forms - ion. P loses an electron while Q gains an electron, so ion of P will have fewer electrons than ion of Q. Moreover, P will have a smaller atomic number than Q (same period) as metals are on the left hand side of the Periodic table. The lattice of the compound is similar to NaCl, hence the formula has the same ratio, ie. PQ. From the diagram, the ratio of the cation : anion is 1:1, hence the formula is PQ. <i>Marker's comment: Not as well done.</i>
6	B	In the solid iron, only the electrons are mobile, not the positive ions. Metallic bonding exists in iron, not ionic bonding. Pure iron is malleable due to the orderly layered arrangement of the atoms(ions). <i>Marker's comment: Not as well done, many students chose option A.</i>
7	D	Silicon carbide has a giant covalent structure.
8	D	The added metal (zinc) is randomly spread out throughout the pure metal (copper).
9	C	Stable noble gas electronic configuration for H = 2, O = 8 electrons, C = 8 electrons
10	A	Rate: need to measure time: stopwatch Mass of Mg : electronic balance Volume of H_2SO_4 : measuring cylinder
11	D	R_f = distance travelled by solute (x) / distance travelled by solvent (y), Iron (III) hydroxide is reddish-brown in colour
12	B	Calcium carbonate is insoluble in water while copper (II) sulfate is soluble in water. Hydrated copper (II) sulfate cannot be obtained by evaporation to dryness as it is not stable to heat. <i>Marker's comment: Not as well done, many students chose option A.</i>
13	C	Drying agent should always be at the last stage to remove any moisture from passing the gas into water. Bubble the gas into the water/drying agent. Tube should be dipped into the water/drying agent.

		Option A is an open thistle funnel which will allow the gas produced to escape, so it is not appropriate.
14	D	As excess HCl is used, the concentration decreases as reaction proceeds, but does not go to zero. Volume of hydrogen increases at a decreasing rate as the reaction proceeds as reactants are used up. It cannot be a constant rate (proportional)-from expts, the gas is produced quickly and then slows down. <i>Marker's comment: Not as well done, many students chose option A.</i>
15	A	Ethanoic acid which is a weak acid will have a higher pH than a strong acid at the same concentration. Not all bases (metal oxide or metal hydroxide) are soluble in water. Only alkalis (soluble bases) react with nitrates to produce ammonia, not all bases. Oxides of metals are either basic or amphoteric in nature. <i>Marker's comment: Not as well done as many students chose other options.</i>
16	D	In precipitation of insoluble lead (II) sulfate, both starting materials have to be soluble. Only lead (II) nitrate is soluble. <i>Marker's comment: Not well done.</i>
17	B	Strong acids react faster than weak acids. Hence, from the information, it can be deduced that butanoic acid is a weak acid and hydrochloric acid is a strong acid. Strong acids are fully dissociated while weak acids are only partially dissociated in water to produce H^+ ions.
18	D	As tin oxide is amphoteric, it can react with both acid and alkali while calcium oxide which is a basic oxide can only react with acids. <i>Marker's comment: Not well done.</i>
19	C	The diagram shows the steps for "add excess of insoluble solid to acid" method to prepare soluble salts (non SPA). A: copper does not react with acid B: reaction of sodium with acid is too reactive, unsafe. Sodium sulfate should be prepared by titration D: barium sulfate is an insoluble salt, hence procedure is incorrect even though the reactants are correct <i>Marker's comment: Not well done.</i>
20	D	In the presence of NaOH, white ppt of zinc hydroxide dissolves in excess NaOH to form a colourless solution. Hence, salt Y contains Zn^{2+}.
21	C	Due to the presence of SO_4^{2-} ions from H_2SO_4, it gives a white ppt of $BaSO_4$ with barium nitrate. (Ca^{2+} also possible) The 2nd test is a positive test for the presence of NO_3^- ions. <i>Marker's comment: Many students chose D.</i>

22	A	Ammonia and chlorine can be tested using litmus paper (red to blue, blue to red and then bleached respectively) Hydrogen and oxygen are neutral gases which can be identified using a lighted splint and glowing splint respectively. <i>Marker's comment: Many students chose B.</i>				
23	B	Precipitate can be formed from these combinations: Q + R (AgCl), P + Q (AgCl), R + S (BaSO ₄) Gas can be formed from reaction of ammonium salt + alkali: S + T <i>Marker's comment: Not well done.</i>				
24	D	Mole ratio: NaHCO ₃ : CO ₂ = 2: 1 No of mole of CO ₂ = 5/2 =2.5 mol Volume of CO ₂ = 2.5 x24 = 60 dm ³				
25	C	Mass of Ru = 5.79 – 1.39 = 4.4g No of moles of Ru = 4.4/101 = 0.04356 mol No of moles of oxygen = 1.39/16 = 0.08688 mol Mole ratio of Ru: O = 0.04356/0.04356 : 0.08688/0.04356 = 1 : 1.99 = 1 : 2 <i>Marker's comment: Not well done.</i>				
26	C	No of moles of Na ₂ SO ₄ = 1 x 25/1000 = 0.025 mol Mole ratio of Na ₂ SO ₄ : BaSO ₄ = 1:1 No of moles of BaSO ₄ = 0.025 mol Expected mass of BaSO ₄ = 0.025 x 233 = 5.825 g % yield = 5.36/5.825 x 100 = 92.01%				
27	C	No of moles of NaOH = 1 x 100/1000 = 0.1 mol Mass of NaOH = 0.1 x [(23 + 16 + 1)] = 4.0 g No of moles of H ₂ SO ₄ = 0.05 x 500/1000 = 0.025 mol Mass of H ₂ SO ₄ = 0.025 x [(2 + 32 + (16 x 4))] = 2.45 g No of moles of KOH = 0.10 x 1 = 0.10 mol Mass of KOH = 0.10 x (39 + 16 + 1) = 5.6 g No of moles of HCl = 0.01 x 2 = 0.02 mol Mass of HCl = 0.02 x [(1 + 35.5)] = 0.73 g <i>Marker's comment: Not well done.</i>				
28	D	For 1g of each compound, No of moles of Al ₂ O ₃ = 1/102 = 0.00980 mol No of moles of oxygen in Al ₂ O ₃ = 0.00980 x 3 = 0.02941 mol No of moles of CuO = 1/80 =0.0125 mol No of moles of oxygen in CuO = 0.0125 mol No of moles of H ₂ SO ₄ = 1/98 =0.01020 mol No of moles of oxygen in H ₂ SO ₄ = 0.01020 x 4 = 0.04082 mol No of moles of HNO ₃ = 1/63 = 0.01587 mol No of moles of oxygen in HNO ₃ = 0.01587 x 3 = 0.04761 mol <i>Marker's comment: Not well done. Many chose A and C.</i>				
29	A	Water is a liquid as room temperature and pressure. <table><tr><td></td><td>CH₄</td><td>O₂</td><td>CO₂</td></tr></table>		CH ₄	O ₂	CO ₂
	CH ₄	O ₂	CO ₂			

		Mole ratio	1	2	1
		Volume	5	10	5
		Volume of excess O₂ = 100 – 10 = 90 cm³ Volume of gases remaining = 90 (excess O₂) + 5 (CO₂) = 95 cm³ <i>Marker's comment: Not well done.</i>			
30	D	<i>Marker's comment: Not well done. Many chose A and C.</i>			