

Candidate Name	Class	Index Number



ST ANDREW'S SECONDARY SCHOOL
MID-YEAR EXAMINATION 2021
SECONDARY 4 EXPRESS

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CHEMISTRY

6092/1

Paper 1

Tuesday

11 May 2021

1 hour

READ THESE INSTRUCTIONS FIRST

Do not open this question paper until you are told to do so.

Write your name, index number and class in the spaces provided on this question paper and the Answer Sheet.

Write in soft pencil.

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

There are **forty** 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.

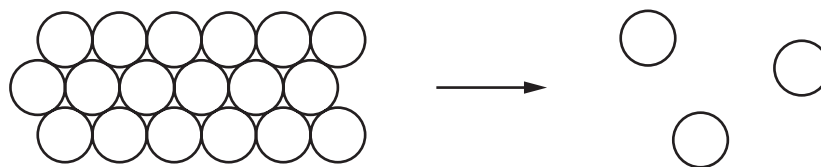
Any rough working should be done in this question paper.

A copy of the Periodic Table is printed on page 16.

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

This question paper consists of 16 printed pages.

- 1 The diagram shows how the arrangement of particles changes during its change in state.

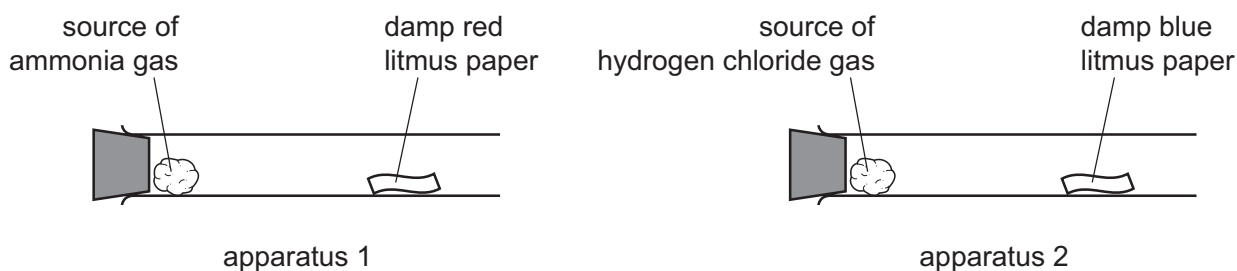


What change in state is shown?

- A** Boiling **B** Condensation **C** Evaporation **D** Sublimation
- 2 A paper chromatography experiment is carried out to separate and identify the mixture of amino acids produced from the hydrolysis of a protein.

Which apparatus is needed?

- A** chromatography paper, pencil, solvent
B chromatography paper, locating agent, ruler, solvent
C chromatography paper, locating agent, pencil, ruler, solvent
D chromatography paper, locating agent, pencil, ruler, solvent, thermometer
- 3 A student investigated the diffusion of ammonia gas and hydrogen chloride gas. Two sets of apparatus were set up at room temperature and pressure.



The damp blue litmus paper in apparatus 2 changed colour after 30 seconds.

How long does it take for the damp red litmus paper to change colour in apparatus 1?

- A** 13 seconds
B 22 seconds
C 30 seconds
D 64 seconds
- 4 Chloroform, CHCl_3 , is an organic solvent once used as an anaesthetic. CHCl_3 has a boiling point of 61.2°C .

A test tube of CHCl_3 was found contaminated with a very small amount of water.

What is the boiling point of a sample obtained from this test tube?

- A** 60.5°C **B** 61.2°C **C** 61.9°C **D** 100°C

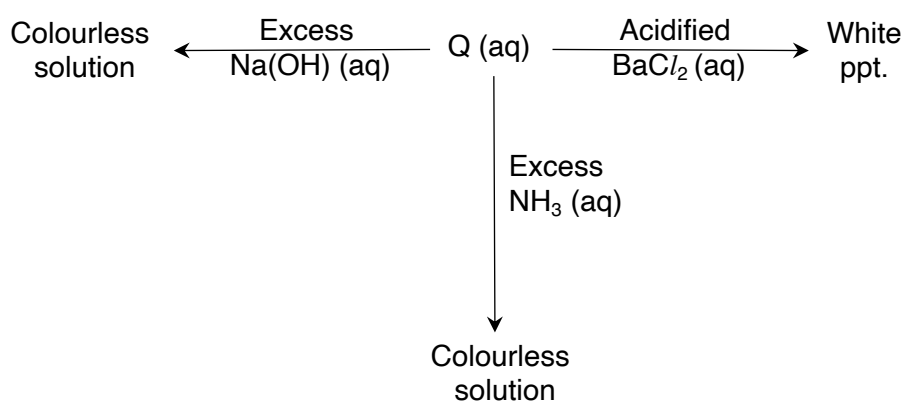
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- 5 When heated gently, solid iodine readily forms iodine vapour.

What does this information suggest about the nature of the particles in these two physical states of iodine?

	Solid	Vapour
A	Molecular	Atomic
B	Molecular	Molecular
C	Ionic	Atomic
D	Ionic	Molecular

- 6 The diagram shows some reactions of a solution of Q.



What is the identity of Q?

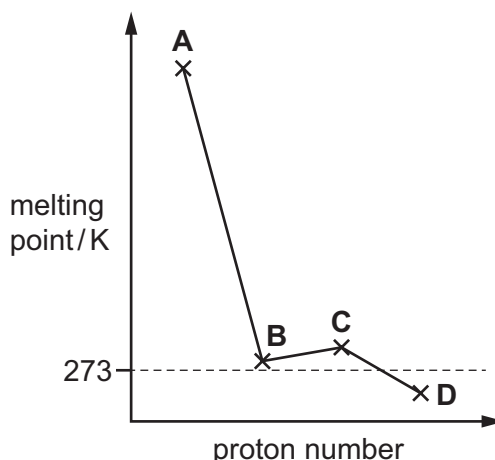
- A $\text{Al}_2(\text{SO}_4)_3$ B $\text{Ca}(\text{HCO}_3)_2$ C H_2SO_4 D PbSO_4
- 7 Which of the following contains one mole of the stated particle?
- A Electrons in 1.00 g of helium
B Electrons in 24.0 dm^3 of hydrogen gas at room temperature and pressure
C Molecules in 19.0 g of fluorine gas
D Protons in 2.00 g of neon
- 8 For the reaction $\text{H}_2 (\text{g}) + \text{F}_2 (\text{g}) \rightarrow 2\text{HF} (\text{g})$, the enthalpy of reaction is -265 kJ/mol of $\text{HF} (\text{g})$ produced.

If the bond energies for $\text{H}_2 (\text{g})$ and $\text{HF} (\text{g})$ are 436 kJ/mol and 562 kJ/mol respectively, what is the bond energy for $\text{F}_2 (\text{g})$ in kJ/mol ?

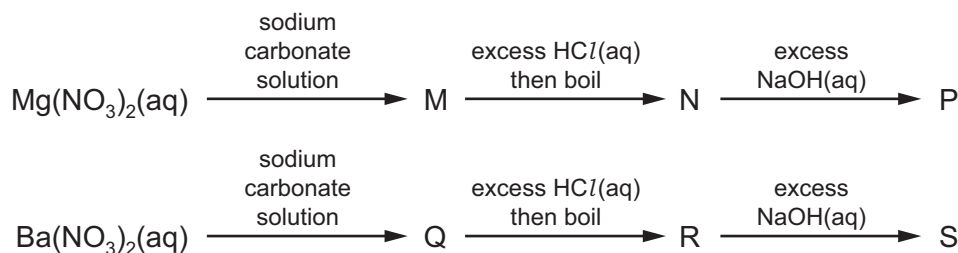
- A 126 B 139 C 158 D 423

- 9 The relative melting points of four consecutive elements in the Periodic Table are shown in the graph. The elements all have proton numbers of less than 20.

Which element could be found in Group VI?



- 10 Solutions of $0.1 \text{ mol/dm}^3 \text{ Mg(NO}_3)_2$ and $0.1 \text{ mol/dm}^3 \text{ Ba(NO}_3)_2$ separately undergo a series of reactions using different reagents.



M, N and P are magnesium compounds.

Q, R and S are barium compounds.

How many of M, N, P, Q, R and S are precipitates?

- A 2 B 3 C 4 D 5
- 11 Which statement about the properties of alkali metals or their compounds is correct?
- A Acidity of the oxides increases down the group.
 B Decomposition temperature of the carbonates decreases down the group.
 C Reactivity of the metals decreases down the group.
 D Thermal stability of the nitrates increases down the group.
- 12 Which compound is composed of a cation and anion(s) that do not contain the same number of electrons as each other?

- A LiH B NaOH C NH_4F D TiCl_3

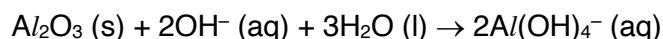
- 13** The following species are involved in the nitrogen cycle: N_2 , NH_4^+ , N_2O , NO_2^- and NO_3^- .

What is the order of increasing oxidation number of nitrogen for these species?

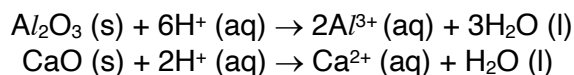
- A** $\text{NH}_4^+ \rightarrow \text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{N}_2\text{O} \rightarrow \text{N}_2$
B $\text{NH}_4^+ \rightarrow \text{N}_2 \rightarrow \text{N}_2\text{O} \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^-$
C $\text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{N}_2\text{O} \rightarrow \text{N}_2 \rightarrow \text{NH}_4^+$
D $\text{N}_2 \rightarrow \text{N}_2\text{O} \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^- \rightarrow \text{NH}_4^+$

- 14** A white powder is known to be a mixture of calcium oxide and aluminium oxide.

100 cm³ of 2 mol/dm³ NaOH (aq) is required to completely dissolve the aluminium oxide in x grams of the mixture:



800 cm³ of 2 mol/dm³ HCl (aq) is required to completely dissolve **all** x grams of the mixture:



How many moles of each oxide are present in x grams of the mixture?

	Al_2O_3	CaO
A	0.05	0.25
B	0.05	0.50
C	0.10	0.25
D	0.10	0.50

- 15** The polyoxometalate $\text{W}_{72}\text{Mn}_{12}\text{Si}_7\text{O}_{268}^{40-}$ was recently identified in a crystal garden.

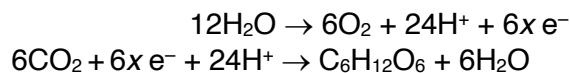
Which row gives the correct oxidation states of W and Mn in this ion?

	Oxidation state of W	Oxidation state of Mn
A	+3	+2
B	+3	+3
C	+6	+2
D	+6	+3

- 16** In plants, photosynthesis absorbs light energy from the Sun that in the presence of chlorophyll in green leaves, converts water and carbon dioxide into glucose and oxygen.

Photosynthesis is a redox reaction involving the following half-equations:

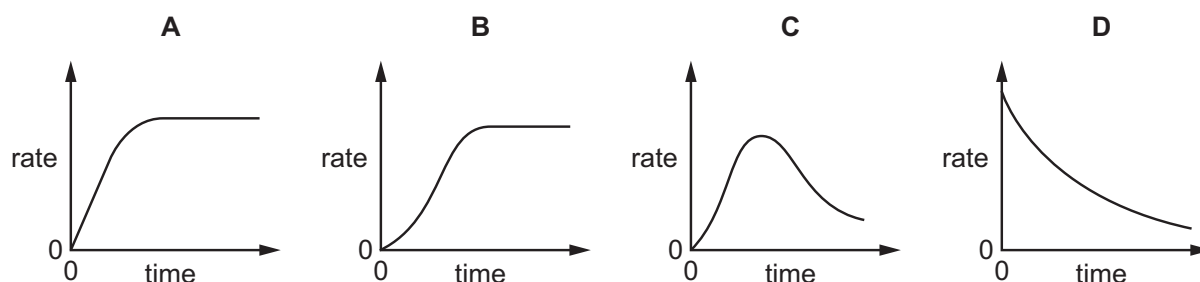
key: e^- represents electron



What is the value of x ?

- A** 2 **B** 4 **C** 12 **D** 24
- 17** Which pair of enthalpy changes are numerically equal?
- A** Atomisation of CH_4 (g) and formation of CH_4 (g)
B Combustion of graphite and combustion of CH_3OH (l)
C Combustion of graphite and formation of CO_2 (g)
D Neutralisation of HCl (aq) with NaOH (aq) and formation of H_2O (g)
- 18** An autocatalytic reaction is a reaction that involves the use of one of the products to catalyse the reaction.

Which curve would be obtained if the rate of an autocatalytic reaction is plotted against time?



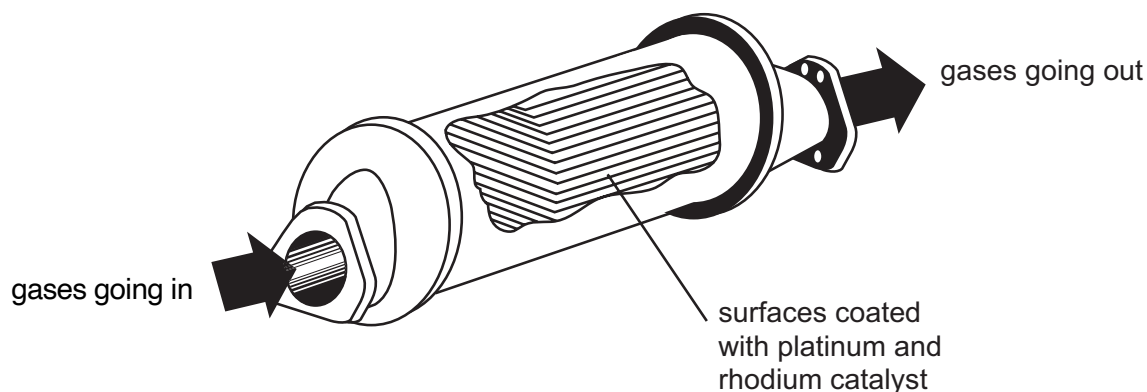
- 19** The rate of a typical chemical reaction is approximately doubled by raising its temperature by 10°C .

What best explains this observation?

- A** Raising the temperature by 10°C doubles the average kinetic energy of each reacting molecule.
B Raising the temperature by 10°C doubles the average velocity of the reacting molecules.
C Raising the temperature by 10°C doubles the number of collisions in any given time.
D Raising the temperature by 10°C doubles the number of molecules with energy greater than the activation energy.

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- 20 The diagram shows a typical catalytic converter that is fitted in most motor cars.

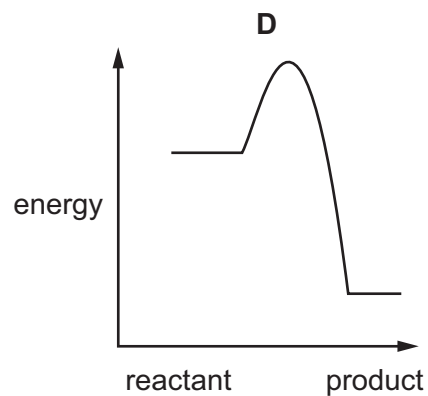
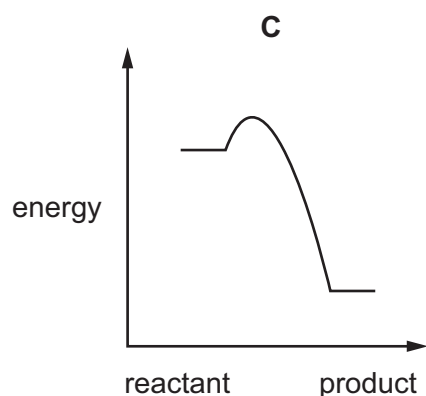
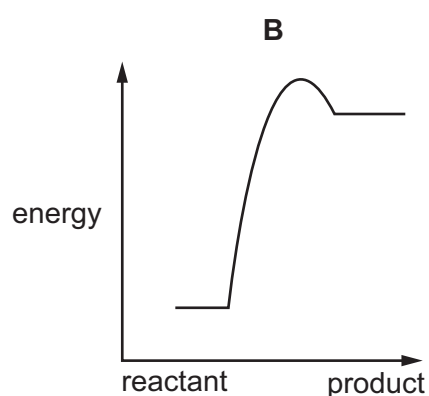
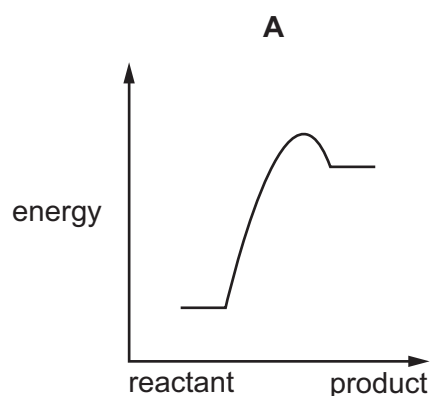


Which unbalanced chemical equation does **not** represent the removal of air pollutants in the catalytic converter from the motor car exhaust fumes?

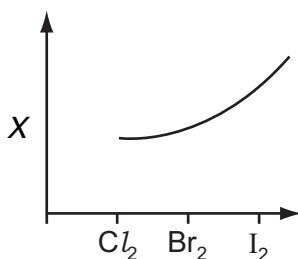
[HC = unburnt hydrocarbons; NO_x = oxides of nitrogen]

- A $\text{CO} + \text{NO}_x \rightarrow \text{CO}_2 + \text{N}_2$
B $\text{CO} + \text{O}_2 \rightarrow \text{CO}_2$
C $\text{HC} + \text{NO}_x \rightarrow \text{H}_2\text{O} + \text{CO} + \text{N}_2$
D $\text{HC} + \text{NO}_x \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{N}_2$
- 21 Four reactions of the same type are studied at the same temperature.

Which represents the correct diagram for the reaction that would proceed most rapidly and with good yield?

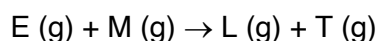


- 22 The graph describes a trend X identified in the halogens.

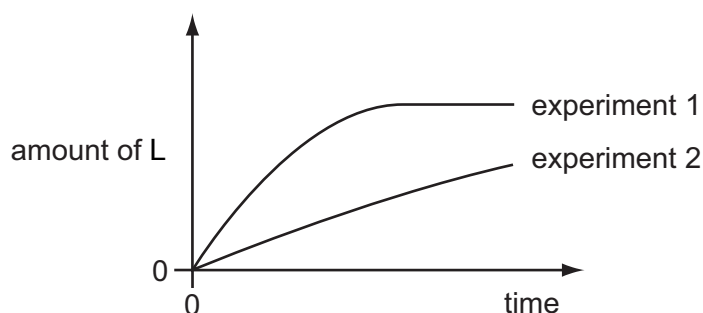


What could be X ?

- A Bond energy
 - B Bond length
 - C Bond strength
 - D Strength of intermolecular forces present
- 23 A catalysed reaction can be represented using the following equation:



Two experiments were carried out in which the production of L was measured against time. The results are plotted in the graph below.



Which of the following changes to the conditions from experiment 1 to experiment 2 might explain the results?

- I Different catalyst used
 - II Decrease in temperature
 - III Less of $E(g)$ reacted
- A I only B I and III only C II and III only D I, II and III
- 24 The following statements are made about the metals Al , Cu , Fe and Mg .

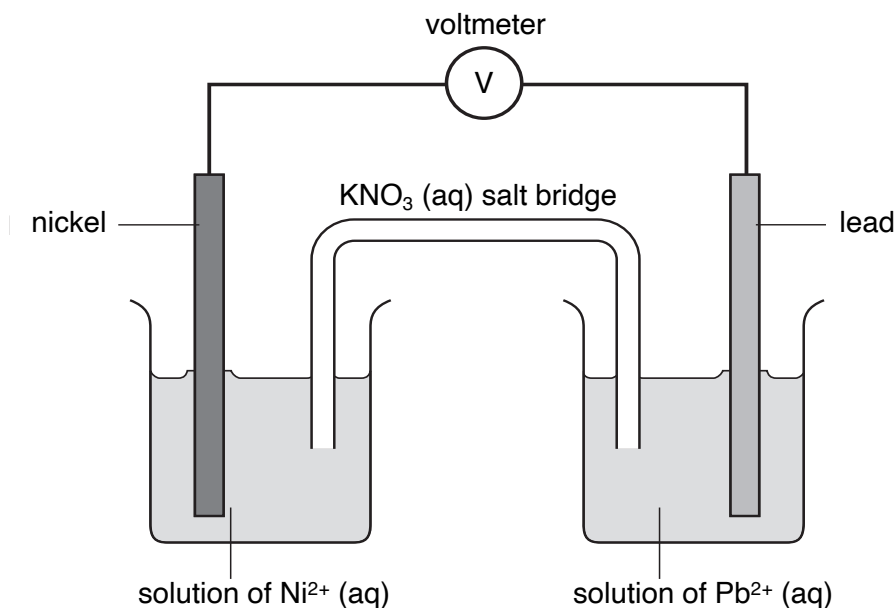
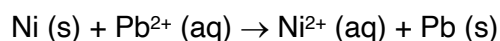
- I All conduct electricity in the solid state.
- II All have high melting points.
- III All react with dilute acids to liberate hydrogen.
- IV Their oxides can react with acids only.

Which statements are correct?

- A I and II only B I and IV only C II and III only D III and IV only

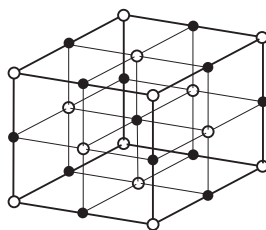
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- 25 The overall reaction in the electrochemical cell below is given as:



Which statement about the nickel half-cell is correct?

- A Nickel is the negative electrode (anode) and is oxidised.
 - B Nickel is the negative electrode (cathode) and is reduced.
 - C Nickel is the positive electrode (anode) and is oxidised.
 - D Nickel is the positive electrode (cathode) and is reduced.
- 26 The diagram shows part of the structure of solid Z at room temperature.



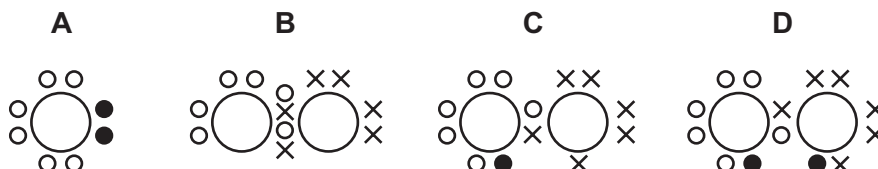
Which pair of particles are most likely present in this structure of solid Z?

	•	○
A	Ca	OH
B	Ca ²⁺	SO ₄ ²⁻
C	NH ₄ ⁺	OH ⁻
D	NH ₄ ⁺	SO ₄ ²⁻

- 27 Barium peroxide is an ionic compound with the chemical formula BaO_2 .
The oxidation state of barium in BaO_2 is +2.

Which diagram best represents the electronic structure of the peroxide anion in BaO_2 ?

key: ○ electron from first oxygen atom × electron from second oxygen atom ● electron from barium atom

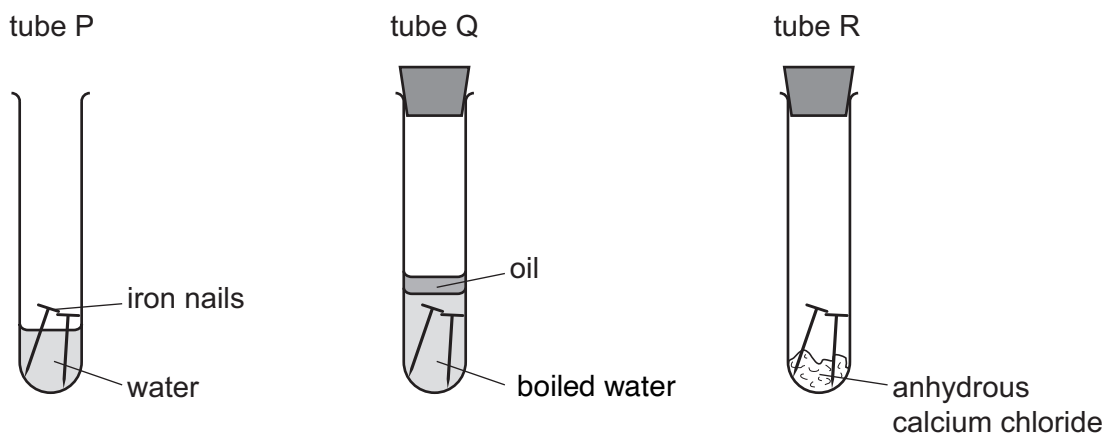


- 28 A motor car released 0.23 g of an oxide of nitrogen N_xO_y , which occupies a volume of 120 cm^3 at room temperature and pressure.

What are the values of x and y ?

	x	y
A	1	1
B	1	2
C	2	1
D	2	4

- 29 The diagrams show experiments involving the rusting of iron.



A student predicted the following results:

- I** In tube P, the iron nails rust.
- II** In tube Q, the iron nails do not rust.
- III** In tube R, the iron nails do not rust.

Which predictions he made are correct?

- A** I and II only **B** I and III only **C** II and III only **D** I, II and III

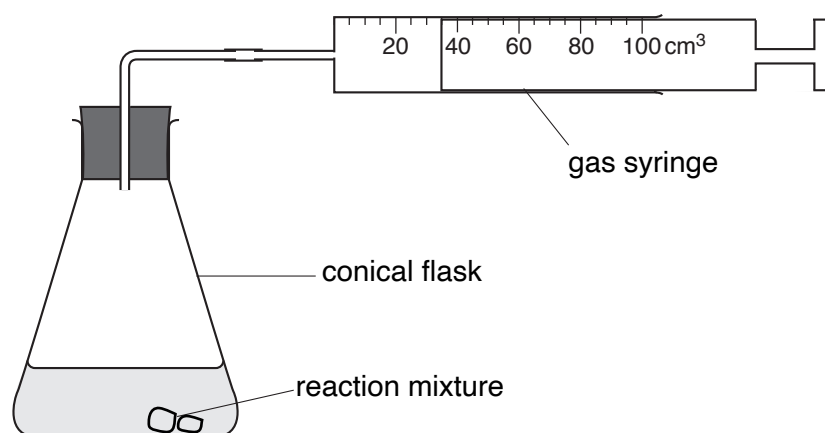
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- 30** During electrolysis of a concentrated solution of sodium chloride, chlorine, hydrogen and sodium hydroxide are produced.

What is the molar ratio of the products?

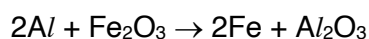
	Chlorine	Hydrogen	Sodium hydroxide
A	1	1	1
B	1	1	2
C	2	1	1
D	2	2	1

- 31** A chemical reaction is being studied using the apparatus shown.



Which reaction is being studied?

- A** Magnesium in dilute acid
B Magnesium chloride in dilute acid
C Magnesium hydroxide in dilute acid
D Magnesium oxide in dilute acid
- 32** Which statements about H_2SO_4 are correct?
- I** Concentrated H_2SO_4 is used as a drying agent for acidic gases.
II It is a dibasic acid.
III It is a reducing agent with the oxidation number of sulfur determined as +6.
- A** I and II only **B** I and III only **C** II and III only **D** I, II and III
- 33** The reaction below is called the 'thermite reaction'.



Which pair of substances can react in a similar way?

- A** Fe and MgO **B** Fe and ZnO **C** Mg and CuO **D** Zn and Al_2O_3

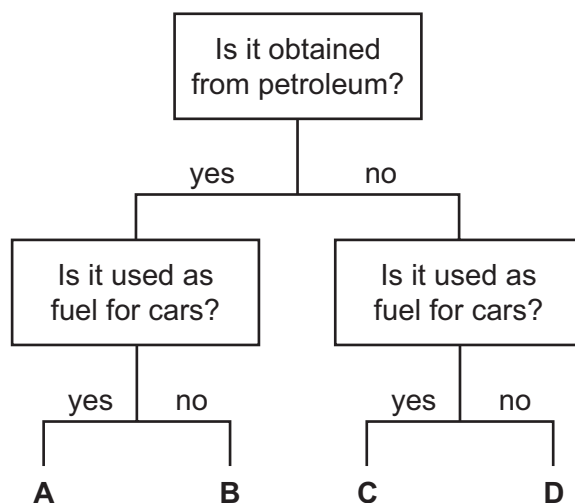
- 34** Rain clouds near a power station are polluted by the gases it released. The power station uses coal with a sulfur content of 1.2% by weight.

Which changes would increase the pH of the rain?

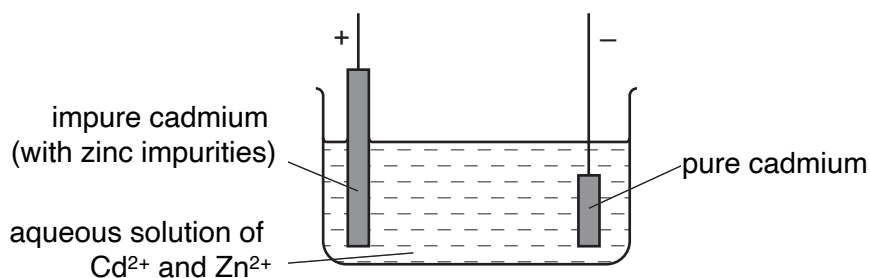
- I** Power station to pass its exhaust gases through slaked lime.
- II** Power station to stop using coal and use 100% pure methane instead.
- III** Power station to use coal with a sulfur content of 0.2% instead.
- IV** Power station to use coal with a sulfur content of 1.5% instead

A I and II only **B** II and III only **C** II and IV only **D** I, II and IV only

- 35** Which fuel could be gasoline?



- 36** Cadmium is a metal used in rechargeable batteries. The purification of cadmium is accomplished through electrolysis.



The following results were recorded in an experiment using the apparatus shown above.

	Mass of pure cadmium electrode / g	Mass of impure cadmium electrode / g
Before the experiment	140	860
At the end of the experiment	700	260

What is the percentage of zinc in the impure cadmium?

A 6.67% **B** 16.3% **C** 23.3% **D** 93.3%

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- 37 Four metals, W, X, Y and Z, were separately reacted with water and dilute hydrochloric acid.

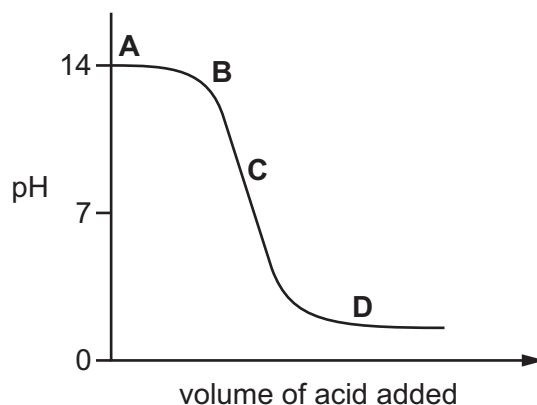
The observations made during the reactions are shown.

	metal			
	W	X	Y	Z
Reaction with water	Fizzes	No reaction	Fizzes vigorously	No reaction
Reaction with dilute hydrochloric acid	Fizzes	No reaction	Fizzes violently	Fizzes

What is the order of reactivity of these four metals?

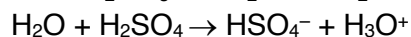
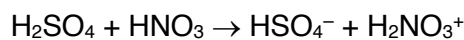
	least reactive → most reactive			
A	X	W	Z	Y
B	X	Z	W	Y
C	Y	W	Z	X
D	Y	Z	W	X

- 38 Which letter represents the area of the graph where both the acid and salt can be found during a neutralisation reaction?



39 Bases are substances that accept H^+ .

The reactions that occur when concentrated sulfuric acid and concentrated nitric acid are mixed are described below.



Identify the substances that are bases in these reactions.

- I** HNO_3
- II** H_2NO_3^+
- III** H_2O
- IV** H_2SO_4

A I and II only **B** I and III only **C** II and III only **D** II and IV only

40 Carbon suboxide, C_3O_2 , is a molecule discovered in 1873 by English Chemist Benjamin Brodie. Analysis shows that the sequence of atoms in this molecule is



How many pairs of electrons in a molecule of C_3O_2 are **not** involved in its bonding?

A 4 **B** 5 **C** 8 **D** 9

END OF PAPER

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