Cambridge Assessment International Education

Cambridge IGCSE™

CHEMISTRY **0620/21**

Paper 2 Multiple Choice (Extended) **May/June 2021**

45 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

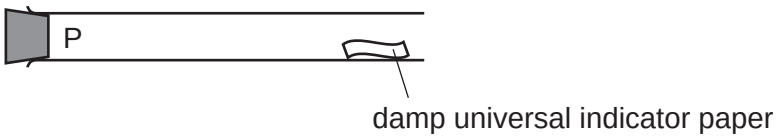
INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

[Turn over

1 A gas is released at point P in the apparatus shown.



Which gas turns the damp universal indicator paper red most quickly?

A ammonia, NH_3

B chlorine, Cl_2

C hydrogen chloride, HCl

D sulfur dioxide, SO_2

The question asks which gas will turn damp universal indicator paper red most quickly.

Concept Overview:
Damp universal indicator paper changes color based on the pH of the gas dissolved in water.
Red color indicates a strongly acidic gas.
The gas must dissolve in water (from the damp paper) to produce an acid.
Analysis of Options:
A) Ammonia (NH_3):

Ammonia is a base (alkaline gas). It would turn the paper blue, not red.
B) Chlorine (Cl_2):

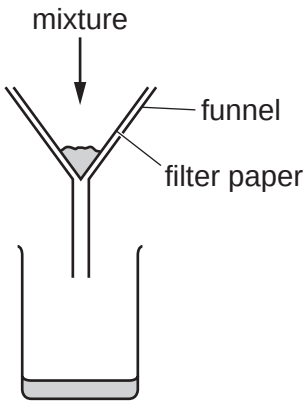
Chlorine gas is slightly acidic when it dissolves in water (forming hypochlorous acid and hydrochloric acid), but it is relatively weak and slower to produce a strong acidic effect.
C) Hydrogen chloride (HCl):

Hydrogen chloride dissolves immediately in water (from the damp paper) to form hydrochloric acid (HCl(aq)), a strong acid.
This will turn the indicator paper red instantly.
D) Sulfur dioxide (SO_2):

Sulfur dioxide dissolves in water to form sulfurous acid (H_2SO_3), which is a weak acid. It would turn the paper light orange or yellow, but not as quickly or strongly as HCl.
Correct Answer:
C) Hydrogen chloride, HCl

Explanation: Hydrogen chloride gas is the most acidic and reacts quickly with the moisture on the universal indicator paper to produce hydrochloric acid, turning it red instantly.

2 A mixture is separated using the apparatus shown.



What is the mixture?

A aqueous copper(II) sulfate and aqueous sodium chloride

B aqueous copper(II) sulfate and copper

C copper and sulfur

D ethanol and ethanoic acid

The apparatus shown is a filtration setup, which is used to separate an insoluble solid from a liquid.

Let's analyze the options:

A) Aqueous copper(II) sulfate and aqueous sodium chloride
Both are soluble in water, so they would pass through the filter paper together.
Filtration cannot separate two dissolved solutions.
Not the answer.
B) Aqueous copper(II) sulfate and copper
Copper is an insoluble solid, and copper(II) sulfate is a solution.
The solid copper would be trapped by the filter paper, while the copper(II) sulfate solution passes through.
This can be separated by filtration.
C) Copper and sulfur
Both copper and sulfur are solids.
Filtration only separates solids from liquids, not two solids.
Not the answer.
D) Ethanol and ethanoic acid
Both ethanol and ethanoic acid are liquids and mix completely (miscible).
Filtration cannot separate two liquids.
Not the answer.

Final Answer: B (Aqueous copper(II) sulfate and copper)

3 Which statement about paper chromatography is correct?

A A solvent is needed to dissolve the paper.

B Paper chromatography separates mixtures of solvents.

C The solvent should cover the baseline.

D The baseline should be drawn in pencil.

Answer

To determine the correct statement about paper chromatography, let's analyze each option:

Statement A: A solvent is needed to dissolve the paper.
This is incorrect. The solvent in paper chromatography is used to dissolve the substances being separated, not the paper itself. The paper acts as a stationary phase.

Statement B: Paper chromatography separates mixtures of solvents.
This is incorrect. Paper chromatography is used to separate mixtures of substances, not solvents. It separates the components of a mixture based on their different affinities for the stationary phase (paper) and the mobile phase (solvent).

Statement C: The solvent should cover the baseline.
This is incorrect. The solvent should not cover the baseline. It should rise from below the baseline so that it carries the sample up the paper as it moves.

Statement D: The baseline should be drawn in pencil.
This is correct. The baseline should be drawn in pencil because pencil marks are not soluble in the solvent and will not interfere with the separation process. Ink, on the other hand, would dissolve and interfere with the results.

Therefore, the correct statement is D: The baseline should be drawn in pencil.

4 Element X has 7 protons.

Element Y has 8 more protons than X.

Which statement about element Y is correct?

A Y has more electron shells than X.

B Y has more electrons in its outer shell than X.

C Y is in a different group of the Periodic Table from X.

D Y is in the same period of the Periodic Table as X.

Answer

Let's analyze the elements based on their proton numbers:

Element X:
Element X has 7 protons, which means it is nitrogen (N).

Element Y:
Y has 8 more protons than X, so it has 7 + 8 = 15 protons. This corresponds to phosphorus (P).

Now, let's evaluate each statement:

Statement A: Y has more electron shells than X.
This is correct. Nitrogen is in Period 2 of the periodic table, while phosphorus is in Period 3. Therefore, phosphorus has more electron shells than nitrogen.

Statement B: Y has more electrons in its outer shell than X.
This is incorrect. Both nitrogen (N) and phosphorus (P) have 5 electrons in their outer shell, as they are both in Group 15 of the periodic table.

Statement C: Y is in a different group of the Periodic Table from X.
This is incorrect. Both nitrogen and phosphorus are in Group 15 of the periodic table.

Statement D: Y is in the same period of the Periodic Table as X.
This is incorrect. Nitrogen is in Period 2, while phosphorus is in Period 3, so they are not in the same period.

Therefore, the correct statement is A: Y has more electron shells than X.

5 A covalent molecule Q contains only six shared electrons.

What is Q?

A ammonia, NH_3

B chlorine, Cl_2

C methane, CH_4

D water, H_2O

Answer

To determine which molecule contains only six shared electrons, let's analyze each option:

Ammonia (NH3):
Ammonia has three hydrogen atoms bonded to one nitrogen atom. Each N-H bond involves 2 shared electrons, resulting in a total of 3 bonds * 2 electrons per bond = 6 shared electrons. This matches the criteria.

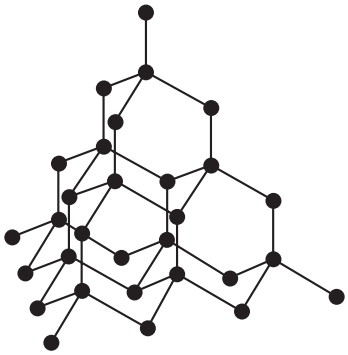
Chlorine (Cl2):
Chlorine consists of two chlorine atoms bonded together. The Cl-Cl bond involves only 2 shared electrons, which does not meet the criteria of six shared electrons.

Methane (CH4):
Methane has four hydrogen atoms bonded to one carbon atom. Each C-H bond involves 2 shared electrons, resulting in a total of 4 bonds * 2 electrons per bond = 8 shared electrons. This exceeds the criteria.

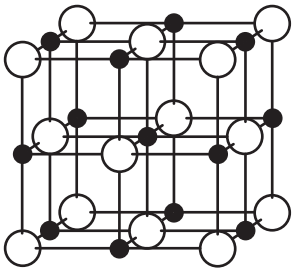
Water (H2O):
Water has two hydrogen atoms bonded to one oxygen atom. Each O-H bond involves 2 shared electrons, resulting in a total of 2 bonds * 2 electrons per bond = 4 shared electrons. This does not meet the criteri**a.**

Therefore, the correct molecule is A: ammonia (NH3), which contains six shared electrons.

6 The arrangement of particles in each of two solids, S and T, are shown.



S



T

What are S and T?

	S	T
A	diamond	silicon(IV) oxide
B	diamond	sodium chloride
C	graphite	silicon(IV) oxide
D	graphite	sodium chloride

In the image:

Solid S shows a three-dimensional tetrahedral structure where each atom is bonded strongly to four others in a regular lattice. This structure is characteristic of a diamond lattice, which is a giant covalent structure of carbon atoms.

Solid T shows a cubic lattice with alternating black and white circles. This pattern represents a regular ionic lattice, where large and small ions alternate in a cubic arrangement. This structure is characteristic of sodium chloride (NaCl), which has a face-centered cubic (FCC) structure.

Explanation of Choices:
S (Diamond): Diamond consists of carbon atoms, each covalently bonded to four other carbon atoms in a tetrahedral arrangement, forming a very hard structure.
T (Sodium chloride): Sodium chloride forms a cubic lattice where sodium ions and chloride ions alternate in a repeating pattern, giving it its crystalline shape.

Correct Answer:
B) S: Diamond, T: Sodium chloride

7 Which statement about metals is correct?

A Metals conduct electricity when molten because negative ions are free to move.

B Metals conduct electricity when solid because positive ions are free to move.

C Metals are malleable because the bonds between the atoms are weak.

D Metals are malleable because the layers of ions can slide over each other.

Answer

To determine which statement about metals is correct, let's analyze each option:

Statement A: Metals conduct electricity when molten because negative ions are free to move.
This is incorrect. Metals conduct electricity due to the presence of free electrons, not negative ions. The electrons move freely in both solid and molten states, allowing metals to conduct electricity.

Statement B: Metals conduct electricity when solid because positive ions are free to move.
This is incorrect. In solid metals, the positive ions are fixed in a lattice structure and do not move. It is the free electrons that enable the conduction of electricity.

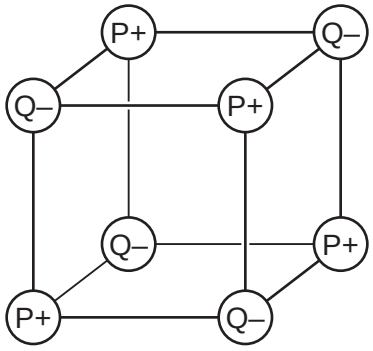
Statement C: Metals are malleable because the bonds between the atoms are weak.
This is incorrect. The bonds in metals are not weak; they are strong metallic bonds. Malleability is not due to weak bonds but rather the ability of the structure to allow the layers to slide.

Statement D: Metals are malleable because the layers of ions can slide over each other.
This is correct. Metals are malleable because their lattice structure allows layers of atoms to slide over each other without breaking the metallic bond. This property allows metals to be shaped and bent.

Therefore, the correct statement is D: Metals are malleable because the layers of ions can slide over each other.

8 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 Element P is non-metallic.

C P is to the left of Q in the Periodic Table.

D The formula of the compound is P_4Q_4.

This question involves periodic table trends and ionic bonding. Let's break it down carefully.

Key Points:
P and Q are in the same period.
They form an ionic compound, which means one is a metal (forms cations) and the other is a non-metal (forms anions).
In a period (left to right):
Metals are on the left, and they lose electrons to form positive ions (cations).
Non-metals are on the right, and they gain electrons to form negative ions (anions).
Analyzing Each Option:
A) An ion of P has more electrons than an ion of Q.
P (cation): Lost electrons, has fewer electrons than its neutral atom.
Q (anion): Gained electrons, has more electrons than its neutral atom.
Therefore, the anion (Q) has more electrons than the cation (P).
A is incorrect.
B) Element P is non-metallic.
They form an ionic compound, which typically occurs between a metal and a non-metal.
Since P forms a cation (P), it must be a metal, not a non-metal.
B is incorrect.
C) P is to the left of Q in the Periodic Table.
In the same period, metals are on the left and non-metals on the right.
P forms P , so it must be a metal, meaning it is on the left.
Q forms Q , so it must be a non-metal, meaning it is on the right.
C is correct.
D) The formula of the compound is P_4Q_4.
Ionic compounds do not form molecular formulas like covalent compounds.
Ionic compounds are represented by their simplest ratio (empirical formula), e.g., NaCl, not Na_4Cl_4.

D is incorrect.
Final Answer: C) P is to the left of Q in the Periodic Table.

9 2.56 g of a metal oxide, MO_2, is reduced to 1.92 g of the metal, M.

What is the relative atomic mass of M?

A 48 **B** 96 **C** 128 **D** 192

Answer

To find the relative atomic mass of the metal M, we can use the given masses and the stoichiometry of the reaction.

Mass of metal oxide (MO2): 2.56 g
Mass of metal (M): 1.92 g
Calculate the mass of oxygen in the metal oxide:

Mass of oxygen = Mass of MO2 - Mass of M = 2.56 g - 1.92 g = 0.64 g

Since the formula for the metal oxide is MO2, it contains two oxygen atoms. The relative atomic mass of oxygen is approximately 16.

The total mass of oxygen in the compound is represented by:

2 * 16 = 32

Setting up a proportion based on masses, we have:

(Relative atomic mass of M) / 32 = 1.92 / 0.64

Solving this proportion, we get:

(Relative atomic mass of M) = 32 * 3 = 96

Therefore, the relative atomic mass of M is B: 96.

10 In separate experiments, electricity was passed through concentrated aqueous sodium chloride and molten lead(II) bromide.

What would happen in **both** experiments?

A A halogen would be formed at the anode.

B A metal would be formed at the cathode.

C Hydrogen would be formed at the anode.

D Hydrogen would be formed at the cathode.

Answer

To determine what happens in both experiments—passing electricity through concentrated aqueous sodium chloride and molten lead(II) bromide—let's analyze each option:

Concentrated Aqueous Sodium Chloride:

At the anode: Chloride ions (Cl-) are oxidized to form chlorine gas (Cl2), which is a halogen.
At the cathode: Hydrogen ions (H+) from water are reduced to form hydrogen gas (H2), rather than sodium metal, because the reduction potential for hydrogen is more favorable.
Molten Lead(II) Bromide:

At the anode: Bromide ions (Br-) are oxidized to form bromine gas (Br2), which is a halogen.
At the cathode: Lead ions (Pb2+) are reduced to form lead metal (Pb).
Now, let's evaluate each statement:

Statement A: A halogen would be formed at the anode.
This is correct. In both experiments, a halogen (chlorine in sodium chloride and bromine in lead(II) bromide) is formed at the anode.

Statement B: A metal would be formed at the cathode.
This is only correct for molten lead(II) bromide, where lead metal is formed. In aqueous sodium chloride, hydrogen gas is formed instead of a metal.

Statement C: Hydrogen would be formed at the anode.
This is incorrect. Hydrogen is not formed at the anode in either experiment.

Statement D: Hydrogen would be formed at the cathode.
This is only correct for aqueous sodium chloride, where hydrogen gas is formed at the cathode. It is not true for molten lead(II) bromide.

Therefore, the correct statement for both experiments is A: A halogen would be formed at the anode.