Comparison between NEW and OLD syllabuses

In the NEW Chemistry syllabus, some topics are newly added and some are removed or deleted. Moreover, the syllabus is divided into two parts: **core** and **extension**. Some difficult topics are grouped under the extension part and they will only be asked in Section B of both Papers 1 and 2.

(a) Topics added into the syllabus

Sections	Topics added
1 Planet Earth	• The atmosphere • The ocean • Rocks and minerals
2 The Microscopic World	• Similarities in chemical properties among elements in Group 0 • Metallic bonding
3 Metals	• Occurrence of metals in nature, in free state and in combined forms • Quantitative relationship of the reactants and products as revealed from a chemical equation • Mole • Percentage by mass of an element in a compound • Empirical formulae derived from experimental data • Reacting masses from chemical equation
4 Acids and Alkalis	• Action on ammonium compounds to give ammonia gas • Rate of reaction
5 Chemical Cells and Electrolysis	• Nitric acid of different concentrations as oxidizing agent to give NO and NO_2
6 Products from Important Processes	• Properties of concentrated sulphuric acid • Preparation of sulphuric acid by 'action of acids on sulphites'
7 Fossil Fuels and of Carbon Compounds	• Alkene • Alkanols
8 Plastics and Detergents	• Moulding methods in relation to their thermal properties • Equation for the production of soaps by relating fats or oil with alkali
9 Detection and Analysis	• Separation of mixtures • Flame test and tests for chloride, bromide, iodide and sulphate ions. • Awareness of the uses of modern chemical instruments

3 Metals

Concept Map

Metals

Occurrence and extraction of metals

Occurrence of metals
- Most metals are found in the Earth as ores.
- Most reactive metals are present as chlorides, carbonates or oxides.
- Less reactive metals are present as sulphides.
- Unreactive metals are present in a free state.

Extraction of metals by reduction
- Metal oxide $\xrightarrow{\text{Heat}}$ Metal + O_2
  (HgO and Ag_2O)
- Metal oxide + C → Metal + CO_2
  (ZnO, Fe_2O_3, PbO and CuO)
- Metal oxide + CO → Metal + CO_2
  (ZnO, Fe_2O_3, PbO and CuO)
- Metal oxide + H_2 → Metal + H_2O
  (Fe_2O_3, PbO and CuO)

Discovery of metals with the ease of extraction and their availability
- Metals discovered early are less reactive.
- Less abundant metals are more expensive.

Conservation of metals
- Reasons for conservation of metals
- Methods of conserving metals
  (1) Reusing metals
  (2) Replacing metals
  (3) Recycling metals

Reactivity of metals

Reaction of metals with oxygen
Metal + O_2 → Metal oxide
e.g. $2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$

Reaction of metals with water / steam
Metal + Water → Metal hydroxide + H_2
e.g. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$
Metal + Steam → Metal oxide + H_2
e.g. $Zn(s) + H_2O(g) \rightarrow ZnO(s) + H_2(g)$

Reaction of metals with dilute acid (HCl / H_2SO_4)
Metal + Acid → Salt + H_2
e.g. $Zn(s) + 2HCl(g) \rightarrow ZnCl_2(s) + H_2(g)$

Metal reactivity series
- The most reactive metal is placed at the top of the series.
- The most reactive metal loses electrons most readily to form positive ion.
- The tendency of elements to lose electrons decreases across a period and increases down a group in the Periodic Table.

Displacement reactions
A more reactive metal will displace a less reactive metal from its aqueous solution.
e.g. $Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$

Reacting masses

Mole, Avogadro's constant and molar mass

- Definitions
- Number of moles

$$= \frac{\text{Mass of the substance in (g)}}{\text{Molar mass in (g / mol)}} \quad \text{OR}$$

$$= \frac{\text{Number of particles}}{\text{Avogadro's number}}$$

Percentage by mass of an element in a compound

$$= \frac{\text{Atomic number of an element} \times \text{Number of element in the compound}}{\text{Formula mass of the compound}} \times 100\%$$

Empirical formula Extension

Methods of calculating empirical formula:
(1) percentage by mass of the elements; and
(2) experimental data.

Equations

Different types of equation:
(1) Word equation
(2) Chemical equation
(3) Ionic equation

Use of equations for calculation

Corrosion of metals and their protection

Corrosion of metals

- Corrosion is the slow reaction of metal with air (oxygen), water or other substances.
- Corrosion of iron is called rusting.

Conditions for rusting

(1) Water
(2) Air (oxygen)

Factors affecting the rate of rusting

(1) Temperature
(2) Presence of electrolytes
(3) Sharply pointed regions
(4) Presence of another metal

Methods of rust prevention

- Surface protection
  (1) Painting
  (2) Oiling / Greasing
  (3) Coating with plastics
  (4) Metal plating
- Sacrificial protection
- Alloying of iron

Socioeconomic implications of iron

Corrosion of aluminium Extension

1.3 Rocks and minerals

Learning Focus

- Recognize that rocks are the source of minerals.
- Learn the method of isolating useful materials from minerals, for example, the extraction of metals from their ores.
- Recognize that limestone, chalk and marble are different forms of calcium carbonate.
- Study the weathering and erosion of rocks.
- Explore the thermal decomposition of calcium carbonate.
- Learn the tests for the presence of calcium and carbonate in a sample of limestone, chalk or marble.

A. Rocks as the source of minerals

- The rock of the Earth is a solid mass of a mixture of minerals（礦物質）.
- Minerals are naturally occurring metal compounds. They have definite crystalline structures and chemical compositions.
- Since many metals are very reactive, they do not exist as free elements. They occur naturally in rocks as compounds in ores（礦石）.
- An ore is a rock that has a lot of a metal compounds.
- These ores are usually metal oxides and sulphides which are mixed with impurities.
- The following table shows the various metals in ores:

Metals	Ores	Metal compounds present in the ore
Sodium	Rock salt	Sodium chloride
Aluminium	Bauxite	Aluminium oxide
Zinc	Zinc blende	Zinc sulphide
Iron	Haematite	Iron(III) oxide
Lead	Galena	Lead(II) sulphide
Copper	Copper pyrite	Copper iron sulphide

Table 1.4

Reminder

Rocks are the source of a wide range of minerals. There are three types of rock:
(1) igneous rock;
(2) sedimentary rock; and
(3) metamorphic rock.

B. Conditions for rusting

- Water and air are essential for rusting.
- The following experiment shows the need of water and air for rusting:

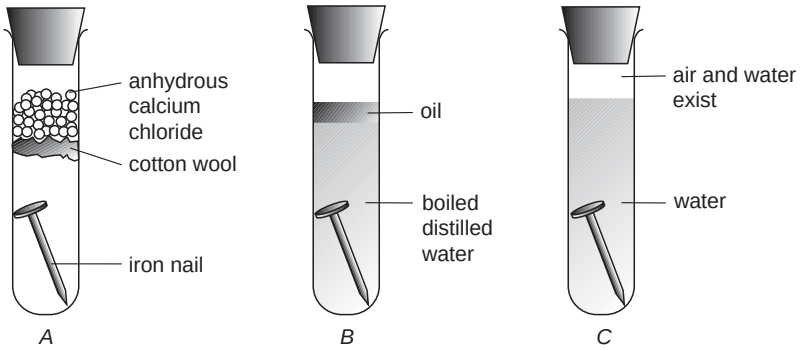

Figure 3.13

  - The test tubes are left for a few days.
  - A few days later, there is no observable change in tubes *A* and *B*. But the occurrence of rusting is observed in tube *C*.
  - Conclusions are made that water and air (oxygen) are both essential conditions for the formation of rust. And that rusting is a slow chemical reaction.

Reminder

- Anhydrous（無水的）calcium chloride ($CaCl_2$) is used to absorb water.
- The word 'anhydrous' must be stated when $CaCl_2$ is used to absorb water.

Reminder

Oxygen in the boiled, distilled water in tube *B* has been driven out. So the nail will not rust due to the absence of oxygen.

C. Factors affecting the rate of rusting

(a) Temperature

- A higher temperature will increase the rate of rusting.
- This is because an increase in temperature always results in an increase in the rate of chemical reactions.

Reminder

Rusting is one kind of chemical reaction.

(b) Presence of electrolytes

- The presence of *electrolytes*, such as acidic solution and soluble salt, will increase the rate of rusting.
- This is because electrolytes increase the electrical conductivity of metals.

Reminder

Electrolytes conduct electricity and decomposed by electrolysis.

(c) Sharply pointed regions

- Rusting will occur at the sharply pointed regions of iron first.
- This is because the charge density is higher around the sharp regions.

(d) Presence of another metal

- If a less reactive metal, such as tin, is wrapped（纏繞）with iron, iron will rust at a faster rate because iron is at a higher position in the metal reactivity series than tin.

- Interpretation
  The rate of formation of carbon dioxide gas is found to be greater when using powdered calcium carbonate.

Guided Example 21

A student added 1 g of powdered calcium carbonate to 40 cm^3 of 1.0 M hydrochloric acid at room temperature and atmospheric pressure. The volume of gas was collected and recorded. The result is graphically represented by curve *X*:

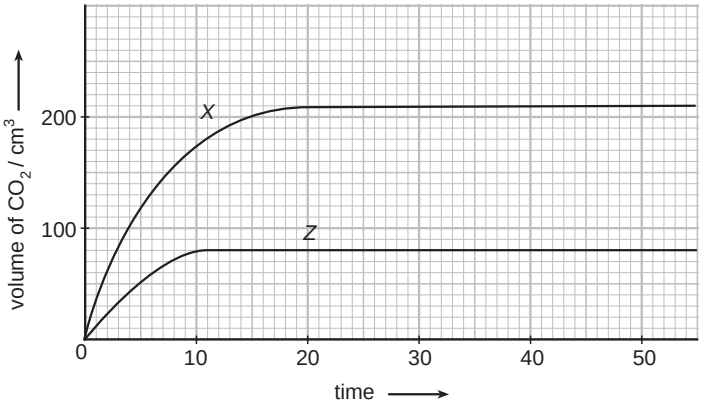

Figure 4.44

(a) Using the same mass of calcium carbonate in the form of marble chips, curve *Y* should be obtained. Sketch curve *Y* on the above graph.

(b) Curve *Z* was obtained when 1.0 g of marble chip was put in 40 cm^3 of 0.5 M sulphuric acid. A student told his teacher the sketched curve *Z* was wrong. Comment on the student's suggestion.
(Assuming there is no change in the temperature and it is under atmospheric pressure.)

Reminder

The surface areas of powdered calcium carbonate and marble chips are different.

Suggested Answer

(a)

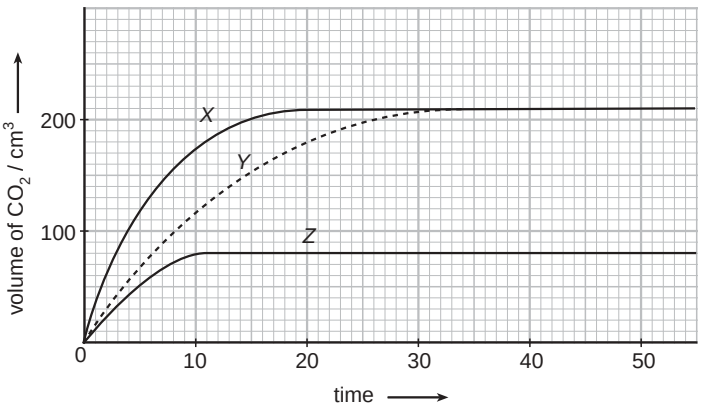

Figure 4.45

(b) The student is wrong.
The final volume of carbon dioxide gas obtained was so small.
This is because a protective layer of calcium sulphate forms on the surface of calcium carbonate.
This layer stops further reaction between calcium carbonate and acid.

- Interpretation
  - An increase in temperature increases the rate of reaction.
  - The graph of (1 / *t* vs. *T*) is NOT a straight line. This indicates that a smaller rise in temperature would greatly increase the reaction rate.

Reminder

1 / *t* represents the rate of reaction.

Guided Example 22

One of the components of an egg shell is calcium carbonate. A student added 50 cm^3 of 2 M hydrochloric acid to 0.1 g of egg shells in a container. After half an hour, all the egg shells had dissolved and carbon dioxide was collected and recorded.

(a) Write an ionic equation for the reaction between calcium carbonate and hydrochloric acid.

(b) The time taken for the reaction was very long. Suggest TWO ways to increase the rate of this reaction without using other chemicals. Explain your answer.

Reminder

'Without using chemical' means that catalyst or larger amount of egg shells cannot be used to fasten the rate of reaction.

Suggested Answer

(a) $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$

(b)
- Crushing the egg shells / making egg shells into powdered form to increase the surface area. A faster reaction rate would be expected.
- Heating the mixture / increasing the temperature would increase the rate of chemical reaction. This is because there is a larger number of particles with enough energy (activation energy) for successful collisions.

Reminder

Calcium carbonate ($CaCO_3$) is insoluble in water, so CO_3^{2-} cannot be written in the ionic equation.

Glossary

acid	酸	neutral	中性的
acidic	酸性的	neutralisation	中和作用
acidity	酸度	pH meter	pH 計
alkali	鹼	pH value	酸鹼值
alkaline	鹼性的	pipette	移液管
alkalinity	鹼度	precipitate	沉澱物
basicity	鹼度 / 鹽基度	standard solution	標準溶液
burette	滴定管	strong acid	強酸
concentration	濃度	strong alkali	強鹼
crystal	晶體	titration	滴定〔法〕
crystallization	結晶	universal indicator	通用指示劑
data logger	數據記錄儀	volumetric analysis	容量分析
evaporation	蒸發	volumtric flask	容量瓶
filtrate	濾液	water of crystallization	結晶水
filtration	過濾	weak acid	弱酸
indicator	指示劑	weak alkali	弱鹼
molarity	摩爾濃度		

Important Formulae

$$\text{Number of moles} = \frac{\text{Mass of substance in (g)}}{\text{Molar mass in (g / mol)}}$$

$$= \frac{\text{Number of particles}}{\text{Avogadro's number}}$$

$$\text{Molarity of a solution (M or mol dm}^{-3}\text{)} = \frac{\text{Number of moles of solute}}{\text{Volume of solution (in dm}^3\text{)}}$$

$$\text{Concentration of a solution (g dm}^{-3}\text{)} = \frac{\text{Mass of a substance}}{\text{Volume of solution (in dm}^3\text{)}}$$

Examination Question Analysis

Topics	Conventional Questions (Year)	Multiple-choice Questions (Year)
Acids	93(3b, 4b), 94(1), 95(7a), 98(4, 8), 00(1), 01(2)	93(23), 94(15, 16, 28), 95(46), 96(15, 33), 97(31, 39, 50), 98(9, 23), 99(37), 01(35), 02(19, 32, 48)
Alkalis	96(6b), 98(3, 4), 01(2), 02(6a, 9a)	97(35, 37), 98(25), 99(20), 00(29), 01(3, 11), 02(17, 24)
Indicators and pH	97(3)	02(5)
Strength of acids and alkalis	96(6b), 00(7a)	94(33)
Neutralisation and salts	93(1b), 95(5), 96(1), 97(7a), 98(6a), 00(4, 6a), 02(7a)	93(43), 94(31), 95(49), 96(6,10), 97(13), 98(12, 31), 00(11, 22, 49)
Concentration of solutions	97(7a)	93(49), 97(6), 00(20)
Simple volumetric work	93(1b, 4b), 94(5a, 8a), 99(7b), 00(7a), 01(6a), 02(9b)	94(30), 95(8, 9, 12, 16), 96(28, 49), 97(14), 98(16, 28), 99(6, 25), 01(34)
Rate of reaction	93(4b), 94(8a)	93(39, 40)

Demonstration

Paper I Conventional Questions

Section A

1. The flow chart below shows some reactions of a greenish-blue solid *A*.

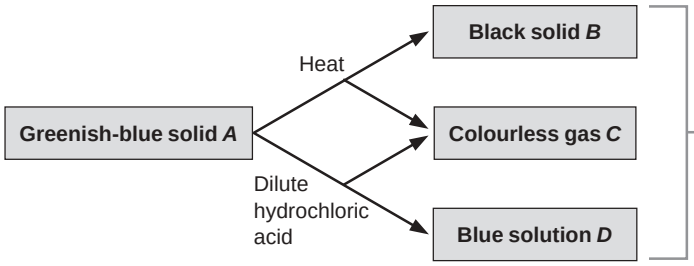

Figure 4.48

Guidelines
In this kind of question, the colour can determine the names of the compounds.

(a) Gas *C* turns limewater milky. Suggest the names of *A*, *B* and *C*.

Guidelines
Writing the answer in formulae is NOT accepted.

(b) Suggest a method by which the black solid *B* can be converted to a metal in the laboratory. Write an equation for the reaction involved.

(c) What will be observed when aqueous sodium hydroxide is added to the blue solution *D*? Write an equation for the reaction involved.

(d) The blue solution *D* can be converted to greenish-blue solid *A*. Suggest how this can be done in the laboratory.

(8 marks)

Suggested Answer

(a) A: Copper(II) carbonate 1
B: Copper(II) oxide 1
C: Carbon dioxide 1

Guidelines
Town gas consists of carbon monoxide and hydrogen. Both of them are oxidizing gases.

(b) By passing town gas through combustion tube which contains CuO(s). 1

$CuO(s) + CO(g) \rightarrow Cu(s) + CO_2(g)$

OR $CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(l)$ 1

(c) Blue precipitate is formed. 1

$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ 1

Guidelines
$K_2CO_3(aq)$ can also be used instead of $Na_2CO_3(aq)$.

(d) By adding sodium carbonate (Na_2CO_3) solution to solution *D*, the greenish-blue solid *A* would be formed. 1

Paper II Multiple-choice Questions

Section A

1. Which of the following is a correct representation of the atomic structure of atom $^{65}_{30}X$?

	Number of protons	Number of neutrons	Number of electrons
A.	30	30	65
B.	35	35	30
C.	30	35	30
D.	35	30	35

Answer: C

Guidelines

- Atomic number = Proton number = Electron number
- Mass number = Proton number + Neutron number

2. Which of the following statements about water molecule is / are correct?

(1) It is formed by electron transfer.
(2) It has low conductivity of electricity.
(3) It is a giant covalent substance.

A. (1) only
B. (2) only
C. (1) and (2) only
D. (2) and (3) only

Answer: B

Guidelines

Water molecules are held by weak van der Waals' forces.

3. Which of the following pairs has an equal number of electrons?

A. Ne, Na^+
B. O^{2-}, S^{2-}
C. Ar, F^-
D. Na^+, Mg^+

Answer: A

Guidelines

Students should write down the electronic arrangement of each pair first.

4. The electronic arrangement of an element $^{11}_{5}X$ (X is represented as a symbol) is

A. 5
B. 6
C. 2, 3
D. 2, 5

Answer: C

Guidelines

The electron number is equal to the atomic number, which is equal to 5. So the electronic arrangement of X is 2, 3.

Practice

Paper I Conventional Questions

Section A

1. The following table gives some information about *P*, *Q*, *R*, *S* and *T*. Which represent either atoms or ions?

Elements	Atomic number	Mass number	Number of electrons	Number of neutrons	Number of protons
P	9	19	9		9
Q	9		10	11	
R	10		10	10	
S	17	35			
T		37	17		17

Table 2.24

(a) *R* is monatomic. Explain why? Hint 1

(b) (i) Which particle(s) is / are the ions? Hint 2
(ii) What is the relationship between *P* and *Q*?
(iii) Do particles of *P* and *Q* have the same chemical properties? Explain your answer.

(c) (i) Suggest a term to indicate the relationship between *S* and *T*.
(ii) Explain why *S* and *T* have the same chemical properties.
(iii) (1) Hydrogen can react with *S* to form a molecule. Draw the electronic structure of this molecule. Give the formula for this molecule. Hint 3
(2) Calculate the relative molecular mass of the compound formed.

(11 marks)

2. The diagram below represents an anion of atom *X*:

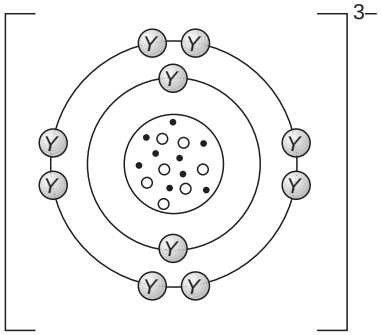

Figure 2.56

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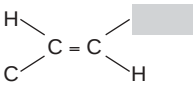
Question Commands

The following table lists the question command(s) which showing the requirements of answering questions:

Question commands	Examples
What / Which ... (Simple answer is usually required.)	What gas evolves? Correct answer: Sulphur dioxide / SO_2 What is the direction of electron flow in the external circuit? Correct answer: From left to right Which of the following compounds can be used to make an addition polymer?  Correct answer: 
Suggest a formula ...	The oxide of aluminium is insoluble in water, suggest the formula for this oxide. Correct answer: Al_2O_3 Incorrect answer: Aluminium oxide
Name ... (Formula / Structure is NOT accepted.)	Name an element which is a metalloid. Correct answer: Boron Incorrect answer: B
Write the chemical equation ... (Although either chemical / ionic equation is accepted. The best answer should be a chemical equation.)	Write a chemical equation for the reaction when adding dilute hydrochloric acid to zinc granules. Correct answer: $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ (chemical equation) Poor answer: $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$ (ionic equation)
Write the chemical equation ...	Write a chemical equation for the reaction between sodium and water. State symbols should be given. Correct answer: $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$ (Score 2 marks) Poor answer: $2Na + 2H_2O \rightarrow 2NaOH + H_2$ (Score 1 mark only) (Remarks: 1 mark for equation and 1 mark for state symbols)
Write an ionic equation ...	Write an ionic equation for the reaction when adding hydrochloric acid to sodium carbonate. Correct answer: $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$ Incorrect answer: $2HCl + Na_2CO_3 \rightarrow H_2O + CO_2 + 2NaCl$