CHAPTER 3: CHEMICAL FORMULAE AND EQUATIONS
BAB 3: FORMULA DAN PERSAMAAN KIMIA

OBJECTIVE QUESTIONS
SOALAN OBJEKTIF

1. The equation below shows the reaction between magnesium and hydrochloric acid,
Persamaan di bawah menunjukkan tindak balas antara magnesium dan asid hidroklorik

$$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

Which of the following statements is true?
Antara pernyataan berikut, yang manakah benar?

[Relative atomic mass of H = 1. Mg = 24, Cl = 35.5]
[Jisim atom relatif H = 1, Mg = 24, Cl = 35.5]

A 1 g of magnesium react with 2 g of hydrochloric acid to produce 1 g of magnesium chloride and 1 g of hydrogen gas
1 g magnesium bertindak balas dengan 2 g asid hidroklorik menghasilkan 1 g magnesium klorida dan 1 g gas hidrogen

B 24 g of magnesium react with 36.5 g hydrochloric acid to produce 95 g of magnesium chloride and 2 g of hydrogen gas
24 g magnesium bertindak balas dengan 36.5 g asid hidroklorik menghasilkan 95 g magnesium klorida dan 2 g gas hidrogen

C 1 mol of magnesium react with 2 mol hydrochloric acid to produce 1 mol of magnesium chloride and 1 mol of hydrogen gas
1 mol magnesium bertindak balas dengan 2 mol asid hidroklorik menghasilkan 1 mol magnesium klorida dan 1 mol gas hidrogen

D 1 magnesium atom reacts with 2 hydrochloric acid molecule to produce 1 magnesium chloride molecule and 1 hydrogen gas molecule
1 atom magnesium bertindak balas dengan 2 molekul asid hidroklorik menghasilkan 1 molekul magnesium klorida dan 1 molekul gas hidrogen

2 The ions that are present in copper(II) sulphate solution are
Ion-ion yang wujud dalam larutan kuprum(II) sulfat ialah

A Cu^{2+}, SO_4^{2-}

B Cu^{2+}, SO_4^{2-}, H^+

C Cu^{2+}, SO_4^{2-}, OH^-

D Cu^{2+}, SO_4^{2-}, H^+, OH^-

3 Which of the following pair of compounds and formulae is correct?
Antara berikut, yang manakah pasangan sebatian dan fomulanya betul?

	Compound ***Sebatian***	**Formula** ***Formula***
A	Sodium sulphate *Natrium sulfat*	$NaSO_4$
B	Copper(II) oxide Kuprum(II) oksida	Cu_2O
C	Iron(III) chloride *Ferum(III) klorida*	$FeCl_3$
D	- Zinc nitrate *Zink nitrat*	$Zn(NO_2)_3$

4 Which of the following chemical formulae of Plumbum(II) carbonate?
Antara formula kimia berikut, yang manakah formula bagi Plumbum(II) karbonat?

A $PbCO$
B $PbCO_3$
C $Pb(NO_3)_2$
D $Pb(NO_3)_2$

5 Given the formulae for calcium ion is Mg^{2+} and nitrate ion is NO_3^-. Choose the correct chemical formula of magnesium nitrate.
Diberi formula ion kalsium ialah Mg^{2+} *dan ion karbonat ialah* NO_3^-*.Pilih formula kimia yang betul bagi magnesium nitrate.*
A $MgNO_3$
B $MgNO_2$
C $Mg(NO_3)_2$
D $MgCO_3$

6 Table below shows the percentage by mass of each element in a compound and their relative atomic masses.
Jadual di bawah menunjukkan peratusan mengikut jisim bagi setiap unsur dalam satu sebatian dan juga jisim atom relatif masing-masing.

Elements ***Unsur***	C	H	O
Percentage (%) ***Peratus (%)***	26.70	2.20	71.10
Relative atomic mass ***Jisim atom relative***	12	1	16

What is empirical formulae of the compound?
Apakah formula empiric bagi sebatian tersebut
A CHO
B CHO_2
C CH_2O
D C_2HO

7 1.04 g of metal M react with 0.48 g of oxygen to form M oxide. Determine the empirical formula of M oxide.
1.04 g logam M bertindak balas dengan 0.48 g oksigen untuk membentuk oksida M. Tentukan formula empirik oksida M.
[Relative atomic mass / *jisim atom relatif*: O = 16 ; M = 52]
A MO
B MO_2
C M_2O_3
D M_3O_2

8 The following equation represents a reaction.
Persamaan berikut mewakili satu tindak balas.

$$3H_2\,(g) + N_2\,(g) \rightarrow 2NH_3\,(g)$$

What is the relative molecular mass of the product?
Apakah jisim molekul relative bagi hasil tersebut?
[Relative atomic mass/ *Jisim atom relatif*: H=1; N=14]

A 2
B 17
C 28
D 34

9 Which chemical equations represents the reaction between sodium metal and oxygen gas?
Persamaan kimia manakah yang mewakili tindak balas antara logam natrium dan gas oksigen?

A $Na + O_2 \rightarrow NaO_2$

B $Na + O_2 \rightarrow Na_2O$

C $2Na + O_2 \rightarrow Na_2O$

D $4\ Na + O_2 \rightarrow 2\ Na_2O$

10

The following equation represents the combustion of methane.
Persamaan berikut mewakili pembakaran metana.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Calculate the volume of carbon dioxide formed at standard temperature and pressure if 3.2 g of methane is used.
Kira isipadu karbon dioksida yang terhasil pada suhu dan tekanan piawai jika 3.2 g metana digunakan.
(Relative atomic mass/ *Jisim atom relatif* : H=1 , C=12 , O=16)
(Molar volume of gas at standard temperature and pressure 22.4 $dm^3\ mol^{-1}$)
(*Isipadu molar gas pada STP 22.4 $dm^3\ mol^{-1}$)*

A 4.48 dm^3
B 2.24 dm^3
C 1.63 dm^3
D 1.12 dm^3

11

Sodium hydrogen carbonate decompose on heating according to the following equation :
Natrium hidrogen karbonat terurai oleh haba mengikut persamaan berikut :

$$\mathbf{2NaHCO_3\ (s) \rightarrow Na_2CO_3\ (s) + CO_2\ (g) + H_2O\ (l)}$$

If 16.8 g of sodium hydrogen carbonate is used, what is the mass of sodium carbonate produced?
Jika 16.8 g natrium hidrogen karbonat digunakan, berapakah jisim natrium karbonat yang terhasil?
[Relative atomic mass : *Jisim atom relatif : H = 1 ; C = 12 ; O = 16 ; Na = 23]*

A 5.3 g
B 10.6 g
C 21.2 g
D 42.4g

12 Given the formulae for calcium ion is Ca^{2+} and carbonate ion is CO_3^{2-}. Choose the correct chemical formula of calcium carbonate.
Diberi formula ion kalsium ialah Ca^{2+} *dan ion karbonat ialah* CO_3^{2-}*.Pilih formula kimia yang betul bagi kalsium karbonat.*

A $Ca(CO_3)_2$
B $CaCO_3$
C Ca_2CO_3
D $Ca_3(CO_3)_2$

13 Which of the following chemical formulae is correct?
Antara formula kimia berikut, yang manakah betul?

A Li_2O
B KBr_2
C Al_3Cl
D $MgNO_3$

14 A compound with the formulae R_2SO_4, has a relative molecular mass is 42. What is the relative atomic mass for R?
Satu sebatian berformula R_2SO_4 mempunyai jisim formula relatif 142.
Berapakah jisim atom relatif bagi R?

[Relative atomic mass / *Jisim atom Relatif* : S= 32 and O = 16]
A 23
B 27
C 39
D 85.5

15 Which of the following pairs of ions have the same number of electrons?
Antara pasangan ion berikut yang manakah mempunyai bilangan elektron yang sama?
[Proton number : Na, 11 ; Mg, 12 ; Cl, 17 ; K, 19 ; Ca, 20]
[Nombor proton : Na, 11 ; Mg, 12 ; Cl, 17 ; K, 19 ; Ca, 20]
A K^+ and Cl^-
K^+ dan Cl^-
B Ca^{2+} and Mg^{2+}
Ca^{2+} dan Mg^{2+}
C Na^+ and Cl^-
Na^+ dan Cl^-
D K^+ and Na^+
K^+ dan Na^+

STRUCTURE QUESTIONS
SOALAN STRUKTUR

1 (a) Table 1.1 shows formula of several ions.
Jadual 1.1 menunjukkan formula bagi beberapa ion.

Ion name Nama ion	Silver ion ion argentums	Zinc ion ion zink	Nitrate ion ion nitrat	Chloride ion ion klorida
Formula of ion Formula ion	Ag^+	Zn^{2+}	NO_3^-	Cl^-

Write the formula for zinc chloride and zinc nitrate.
Tuliskan formula kimia bagi zink klorida dan zink nitrat

Zinc chloride
zink klorida
: ……

Zinc nitrate
zink nitrat : ……

[2 mark/2 markah]

(b) When silver nitrate solution is added to zinc chloride solution, a white precipitate silver chloride and zinc chloride solution produced.
Apabila larutan argentum nitrat ditambahkan kepada larutan zink klorida, mendakan putih argentum klorida dan larutan zink nitrat terhasil.

(i) Name the reactant
Namakan bahan tindak balas.
……

[I mark/ *1 markah*]

(ii) Name the product
Namakan hasil-hasil tindak balas
……

[1 mark/ 1 markah]

(iii) Write the chemical equation for the reaction take place.
Tuliskan persamaan bagi tindak balas yang berlaku.

……

[2 marks/2 markah]

(c) Silver nitrate decomposed when it is strongly heated according to equation below:
Argentum nitrat terurai apabila dipanaskan dengan kuat mengikut persamaan di bawah :

$$2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$$

(i) When 1 mol of silver nitrate is heated, calculate number of mole of silver and number of mole of oxygen gas produced.
Jika 1 mol argentum nitrat dipanaskan,hitungkan bilangan mol argentum dan bilangan mol gas oksigen yang terhasil.

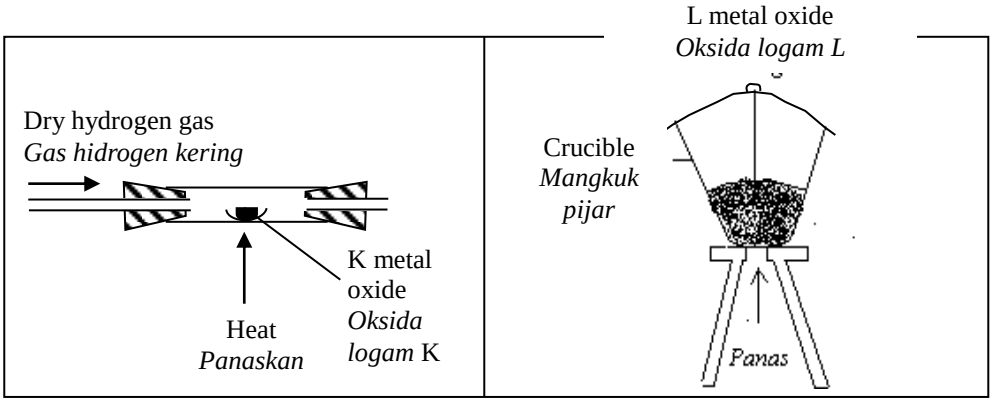
[2 marks/ 2 markah]

(ii) In an experiment, a student heated 85 g of silver nitrate.
Dalam satu eksperimen, seorang pelajar telah memanaskan 85 g argentum nitrat.

Calculate number of mole of silver nitrate and volume of nitrogen dioxide released at room condition.
Hitungkan bilangan mol argentum nitrat dan isipadu gas nitrogen dioksida yang terbebas pada keadaan bilik
[Relative atomic mass / Jisim atom relatif : N, 14; O, 16; Ag, 108 ; 1 mol of gas occupies 24.0 dm^3 at room condition.*1 mol gas menempati 24.0 dm^3 pada keadaan bilik]*

[3 marks/3 markah]

2. Diagram 1 shows the set-up of apparatus for two different experiments to determine the empirical formula for metal oxide and L metal oxide.
Rajah 1 *menunjukkan susunan radas bagi dua eksperimen yang berbeza bagi menentukan formula empirik oksida logam* K *dan oksida logam* L.



Experiment I Experiment II

(a) Suggest a suitable metal for metal K anf metal L.
Cadangkan satu logam yang sesuai bagi logam K dan logam L

……
[2 mark/ 2 markah]

(b) Explain your answer in (a) based on the properties of metal reactivity.
Terangkan jawapan anda di (a) berdasar sifat sifat kereaktifan logam

[1 marks/ 1 markah]

(c) (i) Explain your answer in (a) based on the properties of metal reactivity.
Terangkan jawapan anda di (a) berdasar sifat sifat kereaktifan logam

……

……
[1 marks/ 1 markah]

(ii) In experiment I, describe how dry hydrogen gas can be obtained.
Dalam eksperimen I, huraikan bagaimana gas hidrogen kering diperolehi.

…….
[2 marks/ 2 markah]

(iii) Write the chemical equation involved in (c) (i).
Tuliskan persamaan yang terlibat di (c)(i)

[1 mark/ 1 markah]

(vi) In experiment II, when L metal starts to burn, crucible should be closed and opened once a while until all L have reacted.
The result obtained as follows:

Dalam eksperimen II, apabila logam L mula terbakar, mangkuk pijar perlu ditutup dan dibuka sekali-sekala sehingga semua L bertindak balas. Keputusan yang diperolehi adalah seperti berikut,

Crucible + lid
Mangkuk pijar + tudung = 32.28 g
Crucible + lid + L
Mangkuk pijar + tudung + L = 33.31 g
Crucible + lid + L after heating
Mangkuk pijar + tudung + L selepas pemanasan = 33.99 g

Calculate the empirical formula for L oxide.
Use the information, relative atomic mass for L, 24: O,16
Hitungkan formula empirik oksida L
Gunakan maklumat jisim atom relatif bagi L = 24 dan O = 16

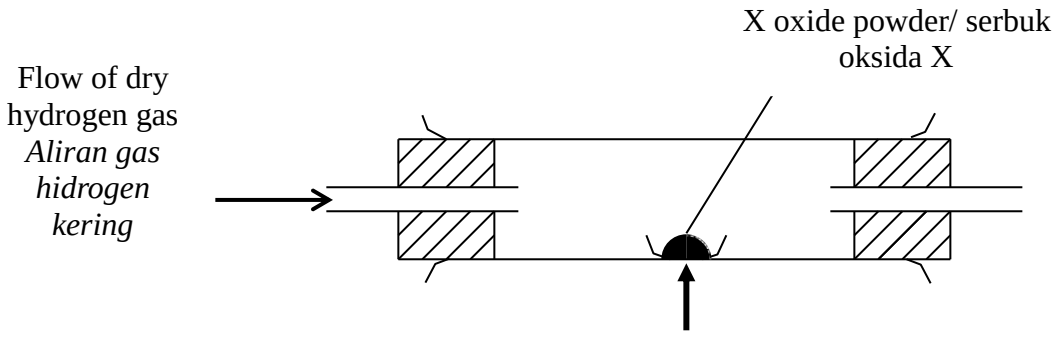
[3 marks/ 3 markah]

e How to ensure the reaction in both experiment is complete?
Bagaimanakah untuk memastikan tindak balas dalam kedua-dua eksperimen lengkap berlaku.

……

[1 *marks / 1 markah*]

3 Diagram 2 shows the set up of apparatus used to determine the empirical formula of X oxide.
Rajah 2 *menunjukkan susunan radas yang digunakan untuk menentukan formula empirik oksida* X.



(a) What is the meaning of empirical formula?
Apakah yang dimaksudkan dengan formula empirik?

[1 mark/ 1 markah]

(b) Before the X oxide powder is heated, the dry hydrogen gas is flowed through the combustion tube for a while. Why?
Sebelum serbuk oksida X dipanaskan, gas hidrogen kering dialirkan melalui tiub pembakaran selama beberapa ketika. Mengapa?

……
……..

[1 mark/ 1 markah]

(c) Suggest a suitable substance for X oxide.
Cadangkan satu bahan yang sesuai untuk oksida X.

……..

[1 mark/ 1 markah]

(d) The followings are the result obtained in the experiment:
Berikut adalah keputusan yang diperolehi dalam eksperimen di atas :

Mass of combustion tube + asbestos paper *Jisim tiub pembakaran + kertas asbestos*	=	157.50 g
Mass of combustion tube + asbestos paper content (before heating) *Jisim tiub pembakaran + kertas asbestos + kandungan (sebelum pemanasan)*	=	173.50 g
Mass of combustion tube + asbestos paper + residue (after heating) *Jisim tiub pembakaran + kertas asbestos + baki (selepas pemanasan)*	=	170.30 g

Determine the empirical formula of X oxide.
[Use information : relative atomic mass : O = 16 ; X = 64]
Hitung formula empirik oksida X.
[*Gunakan maklumat* : *jisim atom relatif* : O = 16 ; X = 64]

[3 *marks/ 3markah*]

(e) The reaction between X oxide and hydrogen producing X and water.
Tindak balas antara oksida X *dengan hidrogen menghasilkan* X *dan air*.

[1 mark/ 1 markah]

(f)

If 2.4 g of X oxide reacts completely with hydrogen, calculate the mass of X produced.
Jika 2.4 g *oksida* X *bertindak balas lengkap dengan hidrogen, hitungkan jisim X yang terhasil*
[Use information : *Relative atomic mass* : O = 16 ; X = 64
[Gunakan maklumat : *jisim atom relatif* : O = 16 ; X = 64]

[3 *marks/ 3 markah]*

4 The following equation is not balanced :
Persamaan berikut adalah tidak seimbang :

$Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + NaCl$

(a) Identify the reactants and products of the reaction.
Kenal pasti bahan tindak balas dan hasil tindak balas bagi tindak balas tersebut.

Reactants/*Bahan tindak balas* : ……
Products/*Hasil tindak balas* ……

[2 *marks/2 markah*]

(b) Write the balanced equation.
Tuliskan persamaan yang seimbang

……

[1 *mark/1markah*]

(c) Calculate/*Hitungkan* :

(i) Tthe number of mole of sodium sulphate that react completely with a solution containing 4.16 *g* of barium chloride
[*Relative atomic mass* : Cl = 35.5; Ba = 137]
bilangan mol natrium sulfat yang bertindak balas lengkap dengan suatu larutan yang mengandungi 4.16 g barium klorida[Jisim atom relatif : Cl = 35.5; Ba = 137]

[2 *marks/ 2 markah*]

(ii) the mass of barium sulphate formed when 1 mol of sodium sulphate is reacted completely with barium chloride.
[*Relative atomic mass* : O = 16; S = 32; Ba = 137]
jisim barium sulfat yang terbentuk apabila 1 mol natrium sulfat bertindak balas lengkap dengan barium klorida.
[Jisim atom relatif : O = 16; S = 32; Ba = 137]

[2 *marks/2 markah*]

ESSEY QUESTIONS
SOALAN ESEI

1. Table 7.1 shows empirical formulae and molecular formulae for ethene.
Jadual 7.1 *menunjukkan formula empirik dan formula molekul bagi etena*.

Empirical Formula ***Formula Empirik***	**Molecular Formula** ***Formula Molekul***
CH_2	**C_2H_4**

Table *1/ jadual 1*

a) Base on the information in Table 7.1, compare and differentiate between empirical formula and molecular formula.of ethene in terms of type of element, number of atom for each element and its relative molecular mass.
[Relative atomic mass : C = 12 ; H = 1]

Berdasarkan maklumat dalam Jadual 7.1, *banding dan bezakan formula empirik dan formula molekul etena dari segi jenis unsur, bilangan atom setiap unsur dan jisim molekul relatif masing-masing*.
[*Jisim atom relatif* : C = 12 ; H = 1]

[3 marks/3markah]

b)
Diagram 7.2 shows the set up of apparatus that a student used to determine the empirical formula of L oxide. L is situated below hydrogen in the Reactivity Series.
Rajah 7.2 *menunjukkan susunan radas yang digunakan oleh seorang pelajar untuk menentukan formula empirik satu oksida* L. L *berada di bawah hidrogen dalam Siri Kereaktifan*.

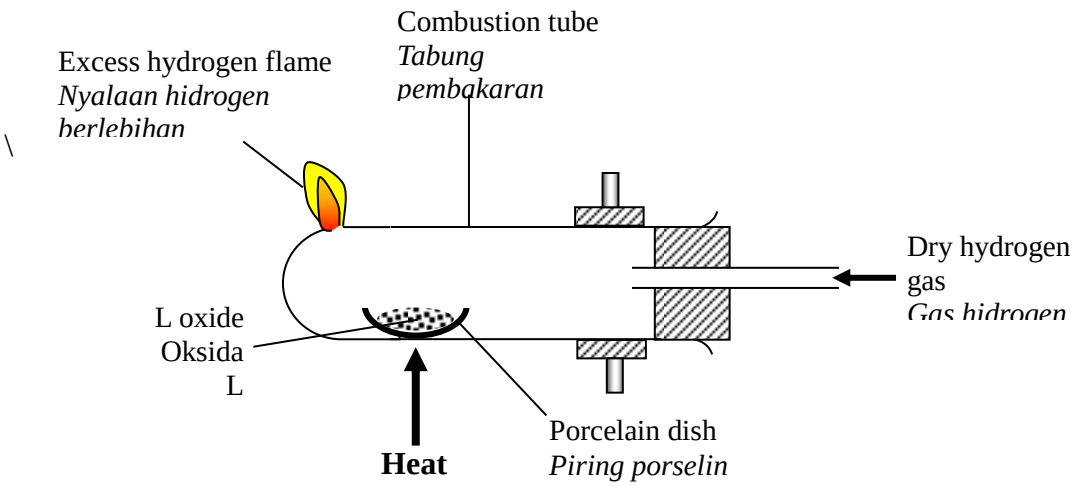


Diagram / *Rajah* 7.2

The result for above experimet is as the following :
Keputusan yang diperoleh dalam eksperimen adalah seperti berikut :

Mass of combustion tube + porcelain dish *Jisim tabung pembakaran + piring porselin*	=	52.45 g
Mass of combustion tube + porcelain dish *Jisim tabung pembakaran + piring porselin + oksida logam L*	=	105.97 g
Mass of combustion tube + porcelain dish *Jisim tabung pembakaran + piring porselin + logam L*	=	102.13 g

Table / *Jadual* 7.3

(i) Based on the information in Table 7.3, determine the empirical formula of L oxide.
Berdasarkan maklumat di atas tentukan formula empirik bagi oksida L
[Relative atomic mass / *jisim atom relatif* : L = 207, O = 16]

[3 mark/ 3 markah]

(ii) Write the chemical equation for the reaction occurred
Tuliskan persamaan kimia bagi tindak balas yang berlaku.

[2 mark/ 2 markah]

(iii) How do you know that the air in the combustion tube has been removed completely before heating?
Bagaimanakah anda tahu bahawa semua udara telah disingkirkan daripada tabung pembakaran sebelum pemanasan?

[2 mark/ 2 markah]

Table 7.4 shows the metals and suitable method to determine their metal oxide empirical formula.
Jadual 7.4 *menunjukkan logam-logam dan kaedah yang sesuai untuk menentukan formula empirik oksida logam masing-masing.*

Metal ***Logam***	**Method** ***Kaedah***
L and copper *L dan kuprum*	Dry hydrogen gas is flow to hot metal oxide. *Gas hidrogen kering dialirkan pada oksida logam yang panas*.
Magnesium	Metal is burnt in air. *Logam dibakar dalam udara*.

Table / *Jadual* 7.4

Explain why the methods are different?
Terangkan mengapa terdapat perbezaan kaedah itu?

[2 mark/ 2 markah]

c (i) $2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$

State **three** informations that you can predict from the above equation.
*Nyatakan **tiga** malumat yang anda dapat tafsirkan daripada persamaan di atas*.

[3 *marks/3markah*]

(ii) Based on the equation, calculate the volume of oxygen gas needed to produce 18 g of water at STP.
Berdasarkan persamaan kimia di atas, hitungkan isipadu gas oksigen pada STP yang diperlukan untuk menghasilkan 18 g *air*.
[Relative atomic mass / *Jisim atom relatif* : H = 1, O = 16]
[Molar volume of gas at STP / *Isipadu molar gas pada STP* = 22.4 dm^3]

[4 mark/ 4 markah]