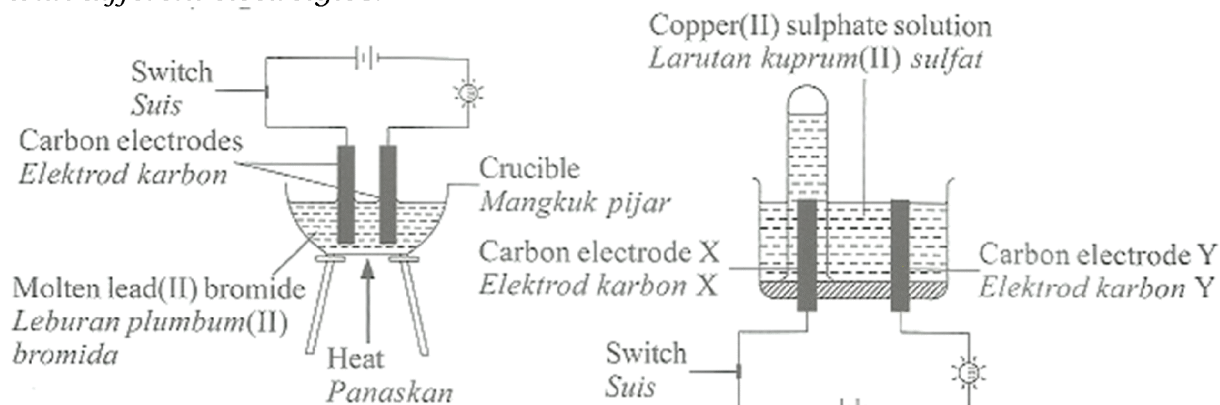


**Cadangan jawapan. Sila rujuk buku teks**

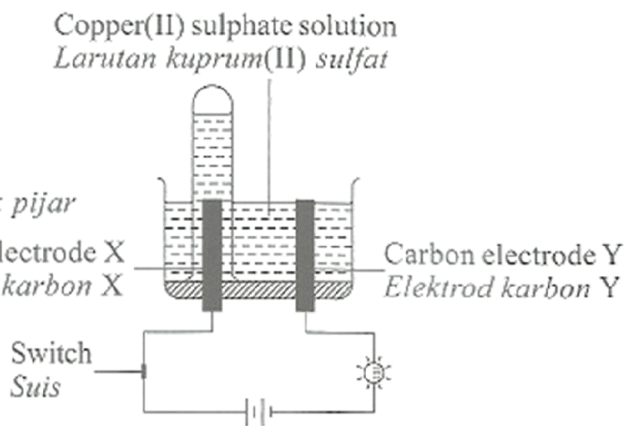
**Bab 09**

**[SPM2014-04]** Rajah 4.1 dan Rajah 4.2 menunjukkan susunan radas bagi dua sel elektrolisis dengan elektrolit yang berlainan.

*Diagram 4.1 and Diagram 4.2 show the apparatus set-up for two electrolytic cells with different electrolytes.*



Rajah 4.1/ Diagram 4.1



Rajah 4.2/ Diagram 4.2

(a) Nyatakan maksud elektrolit./ *State the meaning of electrolyte.*

**Bahan yang dapat mengalirkan arus elektrik dalam keadaan lebur atau larutan akueus dan mengalami perubahan kimia.**

**Substances that can conduct electricity in either the molten state or aqueous solution and undergo chemical changes.**

.....[1M]

(b) Berdasarkan Rajah 4.1,/ *Based on Diagram 4.1,*

(i) mengapakah mentol itu menyala apabila leburan plumbum(II) bromida digunakan sebagai elektrolit?

*Why does the bulb light up when molten lead(II) bromide is used as electrolyte?*

**Contains free moving ion**

**Mengandungi ion-ion yang bebas bergerak**

.....[1M]

(ii) Tulis semua formula bagi ion-ion yang hadir dalam plumbum(II) bromida.

*Write all the formulae for the ions present in lead(II) bromide.*

**Pb<sup>2+</sup> and Br<sup>-</sup> Sebab molten**

.....[1M]

(iii) nyatakan pemerhatian pada katod/ *state the observation at cathode.*

**Thicker/ Grey solid deposited Sebab logam Pb yang terhasil**

**Tebal/ Enapan kelabu terbentuk**

.....[1M]

(iv) tulis setengah persamaan pada katod./ *write the half equation at cathode.*

**Pb<sup>2+</sup> + 2e → Pb**

.....[1M]

Berdasarkan Rajah 4.2, / Based on Diagram 4.2,

(i) nyatakan elektrod manakah adalah anod .....[1M]  
 State which electrode is anode.

Karbon elektrod X/ Carbon electrode X

(ii) nyatakan pemerhatian pada anod. / State the observation at the anode.

Colourless Bubbles gas released

Gelembung gas tak berwarna terbebas

[Sebab faktor kedudukan dan ion OH<sup>-</sup> yang terpilih]

[KSSM – E<sup>0</sup> lebih negatif atau kurang positif lebih mudah di pilih bagi anion]

.....[1M]

(iii) tulis setengah persamaan pada anod. ....[1M]

Write the half equation at the anode.



(d) Dalam Rajah 4.2, anod karbon digantikan dengan kuprum dan elektrolisis dijalankan selama 20 minit. Nyatakan pemerhatian di anod. Beri satu sebab.

In Diagram 4.2, carbon anode is replaced with copper and electrolysis is carried out for 20 minutes. State the observation at the anode. Give a reason.

Copper electrode became thinner. / / elektrod kuprum menjadi nipis

Copper electrode dissolves / / Elektrod kuprum melarut

Copper ionizes / / Kuprum mengion

Copper electrode produce copper(II) ion / / Elektrod Cu menghasilkan ion kuprum(II)

.....[2M]

[SPM2018-04] A student has carried out an experiment of electrolysis for two different acids. The concentration for both of the acids is 1.0 mol dm<sup>-3</sup>. Diagram 4 shows the apparatus set-up for two sets of experiment.

Seorang pelajar menjalankan eksperimen bagi elektrolisis dua asid yang berbeza. Kepekatan bagi kedua-dua asid adalah 1.0 mol dm<sup>-3</sup>. Rajah 4 menunjukkan susunan radas bagi dua set eksperimen itu

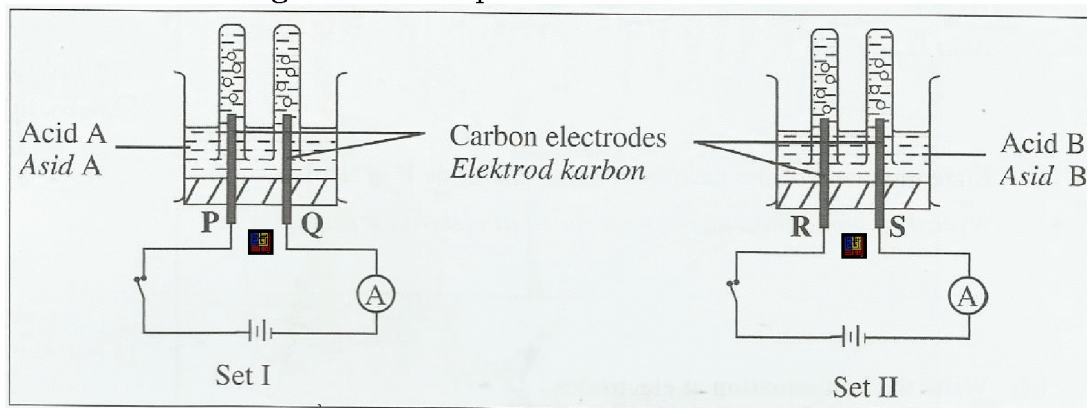


Diagram 4/ Rajah 4

The observation for Set 1 and Set II is shown in Table 1.  
Pemerhatian bagi Set 1 dan Set II ditunjukkan dalam Jadual 1

	Observation/ Pemerhatian	
	Anode/ Anod	Cathode/ Katod
Set I	Colourless gas is released Gas tidak berwarna dibebaskan	Colourless gas is released Gas tidak berwarna dibebaskan
Set II	Greenish yellow gas is released Gas kuning kehijauan dibebaskan	Colourless gas is released Gas tidak berwarna dibebaskan

Table 1/ Jadual 1

(a) What is the meaning of electrolysis?

Apakah yang dimaksudkan dengan elektrolisis?

Proses penguraian suatu sebatian dalam keadaan lebur atau larutan akueus kepada unsur jujuknya apabila arus elektrik mengalir melaluinya.

*A process whereby compounds in the molten state or an aqueous solution decompose into their constituent elements by passing electricity through them.*

..... [1M]

(b) Suggest the names of the acids used in Diagram 4.

Cadangkan nama asid yang digunakan dalam Rajah 4.

Acid A : Sulphuric acid/ nitric acid// Asid sulfurik// Asid nitrik

Acid B : hydrochloric acid// Asid hidroklorik

(c) State the name of the gas produced at electrode P in Set I.

Nyatakan nama bagi gas yang terhasil di elektrod P pada Set I.

Gas Oksigen/ Oxygen gas [P adalah anod]

..... [1M]

(d) Write the half equation at electrodes/Tulis setengah persamaan di elektrod :



(e)(i) What should be done in the experiment if a student wishes to collect the colourless gas at the anode in Set II, without changing the type of acid used?

Give one reason for the formation of colourless gas.

Apakah yang perlu dilakukan dalam eksperimen itu jika seorang murid, ingin mengumpul gas tidak berwarna di anod dalam Set II, tanpa mengubah jenis asid yang digunakan ? Berikan satu sebab bagi pembentukan gas tanpa warna

1. Gunakan asid cair/ use dilute acid

2. OH<sup>-</sup> ion is selected to discharge to form oxygen gas

Ion OH<sup>-</sup> dipilih untuk dinyahcas untuk menghasilkan gas oksigen

..... [2M]

(ii) Write the half equation of reaction occurred at the anode in 4(e)(i).

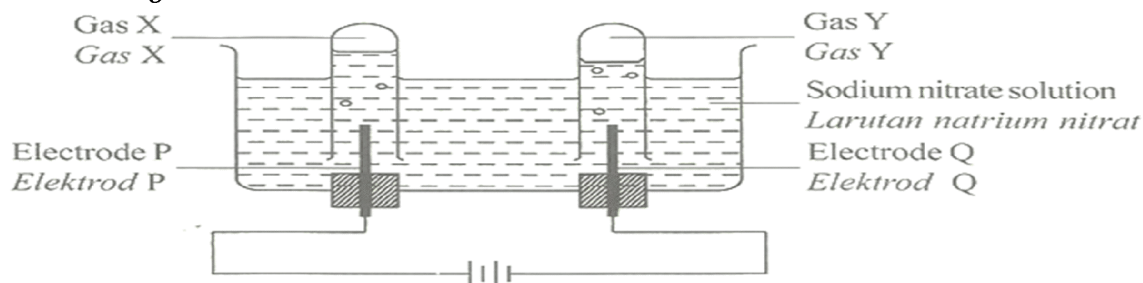
Tulis setengah persamaan bagi tindak balas yang berlaku pada anod di 4(e)(i).



..... [1M]

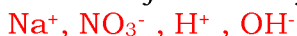
**[SPM2013-04]** Rajah 4 menunjukkan susunan radas untuk elektrolisis larutan natrium nitrat dengan menggunakan elektrod karbon.

Diagram 4 shows the apparatus set-up for the electrolysis of sodium nitrate solution using carbon electrodes.



Tulis formula bagi semua ion yang hadir dalam larutan natrium nitrat.

Write the formulae of all the ions present in sodium nitrate solution.



.....[1M]

(b) Elektrod Q bertindak sebagai katod. / Electrode Q acts as cathode.

(i) Apakah yang dimaksudkan dengan katod?

What is the meaning of cathode?

Elektrod yang disambungkan ke terminal negatif bateri/ sumber elektrik

Electrode that is connected to the negative terminal of battery/ electric source

.....[1M]

(ii) Apakah gas Y? .....[1M]

What is gas Y?

Hydrogen gas// gas hidrogen//  $\text{H}_2$

Terangkan jawapan anda di 4(b)(ii) berdasarkan pemilihan discas ion.

Explain your answer in 4(b)(ii) in term of selective discharge of ions.

1. Ion hidrogen/ $\text{H}^+$  terpilih untuk dinyacas di katod

Hydrogen ion/  $\text{H}^+$  is selctively discharge at the cathode

2. Ion hidrogen/ $\text{H}^+$  terletak lebih rendah daripada ion Natrium/ $\text{Na}^+$  dalam siri elektrokimia

Hydrogen ion/ $\text{H}^+$  located lower than sodium ion/ $\text{Na}^+$  in the electrochemical series

[KSSM - nilai  $E^0$  yang lebih positif atau kurang negatif lebih mudah dinyahcaskan bagi kation]

.....[2M]

(c) Gas X dikumpul di anod. Gas X boleh menyalakan kayu uji berbara.

Tulis setengah persamaan bagi tindak balas di anod.



Gas X is collected at the anode. Gas X can rekindle a glowing splinter.  
Write the half-equation for the reaction at the anode.



.....[2M]

(d) Rosli mendapati anak kuncinya diperbuat daripada besi telah berkarat. Dengan menggunakan pengetahuan tentang elektrolisis, huraikan secara ringkas bagaimana ia menyelesaikan masalah itu.

*Rosli discovers his key which is made up of iron has rusted. By using the knowledge on electrolysis, describe briefly how he solves the problem.*

**By using electroplating metal**

*dengan menggunakan kaedah penyaduran logam*

**Iron key will be connected to negative terminal of dry cell by using connecting wires**

Kunci besi disambungkan ke terminal negatif sel kering dengan menggunakan wayar penyambung

**Silver electrode will be connected to positive terminal of battery by using connecting wires**

*Elektrod argentum disambungkan ke terminal positif sel kering dengan menggunakan wayar penyambung*

**Dip iron key and silver electrode into silver nitrate solution for 20 minute**

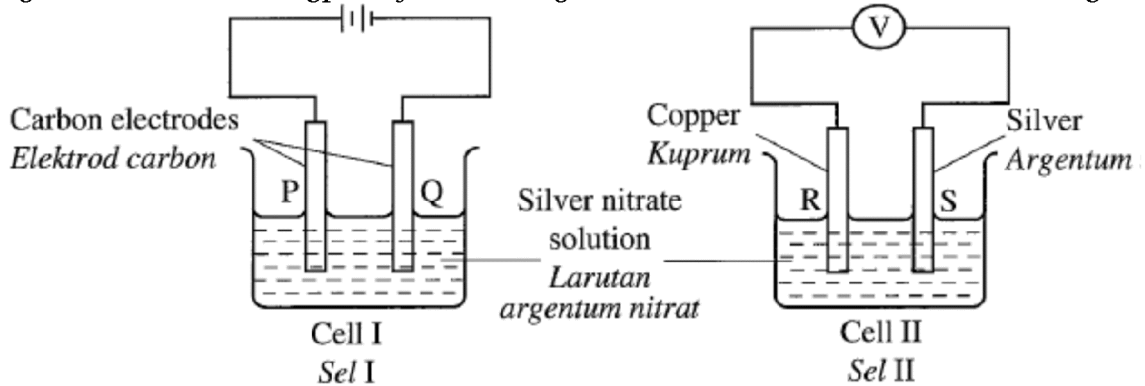
Rendamkan/ tenggelamkan kunci besi dan elektrod argentum ke dalam larutan argemum nitrat selama 20 minit.

**[Ceritakan bagaimana nak buat eksperimen]**

.....[3M]

**[SPM2020-05]** Rajah 5 menunjukkan dua jenis sel yang menggunakan larutan argemum nitrat sebagai elektrolit.

*Diagram 5 shows two types of cells using silver nitrate solution as an electrolyte.*



(a) (i) Nyatakan maksud elektrolit. / *State the meaning of electrolyte.*

**Bahan yang dapat mengalirkan arus elektrik dalam keadaan lebur atau larutan akueus dan mengalami perubahan kimia.**

*Substances that can conduct electricity in either the molten state or aqueous solution and undergo chemical changes.*

..... [1M]

(ii) Tulis formula semua anion yang hadir dalam elektrolit itu.

Write the formula of all the anions present in the electrolyte.

$\text{NO}_3^-$ ,  $\text{OH}^-$

..... [1M]

(b) Bagi Sel I, / For Cell I,

(i) nyatakan ion yang akan dinyahcas di elektrod P, ..... [1M]  
state the ion that will be discharged at electrode P,

Hydroxide ion //  $\text{OH}^-$  // Ion hidroksida

(ii)berikan satu sebab bagi jawapan anda di (b)(i),  
give one reason for your answer in (b)(i),

$\text{OH}^-$  / hydroxide ion is lower than nitrate ion  $\text{NO}_3^-$  in electrochemical series

Ion hidroksida /  $\text{OH}^-$  adalah lebih rendah berbanding ion nitrat /  $\text{NO}_3^-$  dalam siri elekirokimia.

[KSSM –  $E^0$  lebih negatif atau kurang positif lebih mudah di pilih bagi anion]

(iii) tulis setengah persamaan bagi tindak balas di elektrod P.

write the half-equation for the reaction at electrode P.

$4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4e^-$

..... [1M]

(c) Bagi Sel II, tulis setengah persamaan di elektrod R dan elektrod S.

For Cell II, write the half equation at electrodes R and S.

1. Electrode R :  $\text{Cu} \rightarrow \text{Cu}^{2+} + 2e^-$

2. Electrode S :  $\text{Ag}^+ + e^- \rightarrow \text{Ag}$

[2M]

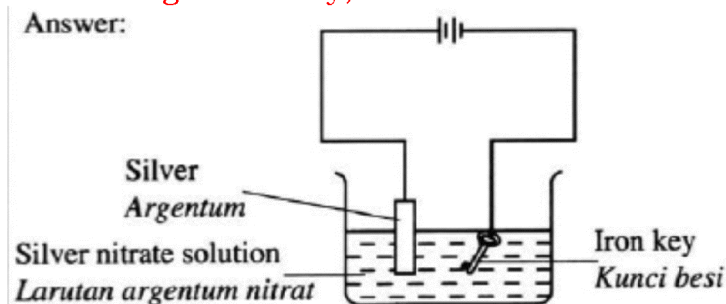
(d) Susunan radas dalam Sel II boleh diubahsuai untuk menyadur kunci besi. Lukis satu rajah berlabel untuk menunjukkan bagaimana penyaduran kunci besi dengan argentum dapat dijalankan.

The apparatus set-up in Cell II can be modified to electroplate iron key.

Draw a labelled diagram to show how electroplating of iron key with silver can be carried out.

1. Functional diagram

2. Labelling of iron key, silver and silver nitrate solution



[2M]

(e) Elektrolit yang manakah dalam Sel I dan Sel II mengalami perubahan warna? Beri satu sebab.

Which of the electrolyte in Cell I and Cell II undergoes a colour change?

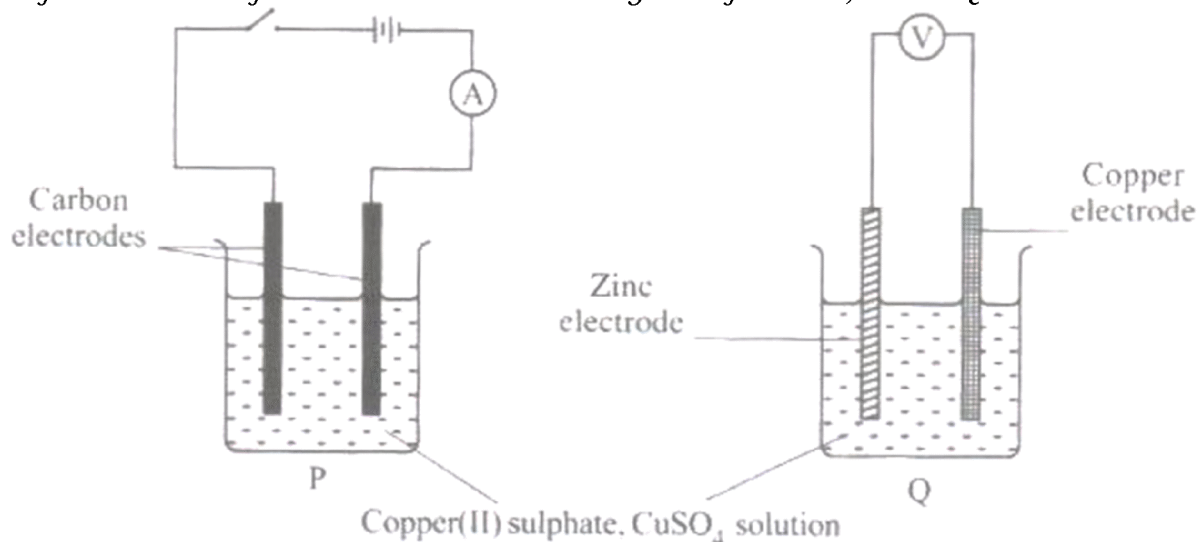
Give a reason.

1. Cell II // Sel II
2. The presence of  $\text{Cu}^{2+}$  ions // Kehadiran ion  $\text{Cu}^{2+}$

..... [2M]

**[SPM2010-05]** Diagram 5.1 shows the apparatus set-up for two types so cells, P and Q.

Rajah 5.1 menunjukkan susunan radas bagi dua jenis sel, P dan Q



(a) What is the colour of copper(II) sulphate solution?

Apakah warna larutan kuprum(II) sulfat?

Blue/ Biru

[Tak perlu perubahan sebab warna asal sahaja]

.....[1M]

(b) State all the anions present in copper(II) sulphate solution.

Nyatakan semua anion yang hadir dalam larutan kuprum(II) sulfat.

Sulphate ion/ ion Sulfat/,  $\text{SO}_4^{-2}$  and hydroxide ion /ion Hidroksida/  $\text{OH}^-$

.....[1M]

(c) Which electrode is the negative terminal in cell Q?

Elektrod manakah yang merupakan terminal negatif dalam sel Q?

Zinc/ zink

.....[1M]

(d) Write the half equation for the discharge of the anion in cell P.

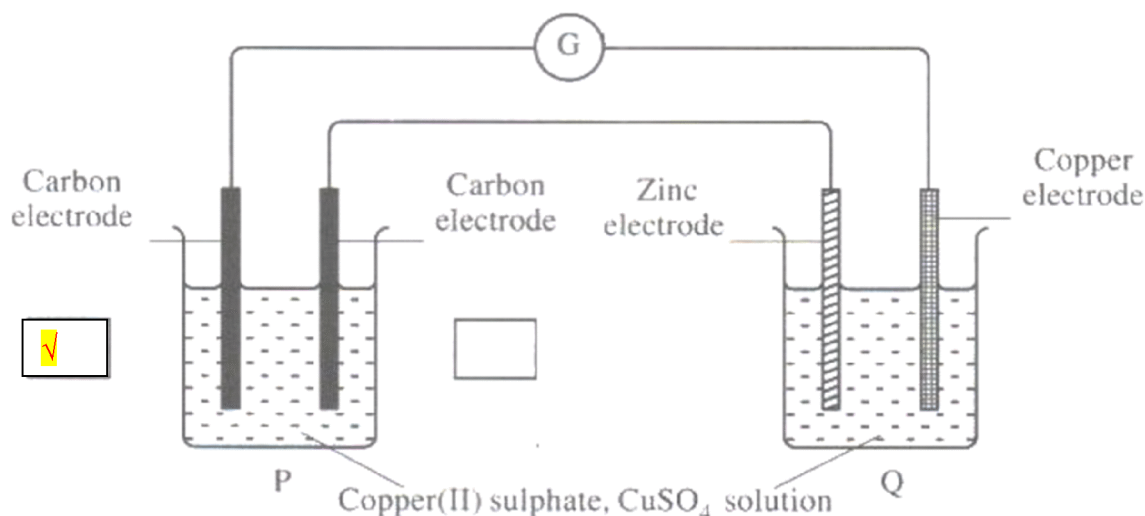
Tulis setengah persamaan bagi anion yang dinyahcas dalam sel P.

$4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$

.....[2M]

(e) Cell P and Cell Q are combined as shown in Diagram 5.2

Sel P dan sel Q digabungkan seperti ditunjukkan dalam Rajah 5.2.



(i) In Diagram 5.2, mark (✓) in the box provided to show which electrode is the anode in cell P. Explain your answer.

Dalam Rajah 5.2, tanda (✓) dalam petak yang disediakan untuk menunjukkan elektrod yang manakah adalah anod dalam sel P. Jelaskan jawapan anda. [2M]

1 Tindak balas pengoksidaan berlaku

Oxidation reaction occurs// lost of electron

2. Electrode is connected to the positive terminal in cell Q

Elektrod bersambung dengan terminal positif sel Q

3. Electron move/ flow from anode to cathode

Elektron bergerak daripada anod ke katod

(ii) The observation for the electrolyte in cell P and cell Q is the same. State the observation and explain your answer.

Pemerhatian bagi elektrolit dalam sel P dan sel Q adalah sama. Nyatakan pemerhatian tersebut dan jelaskan jawapan anda.

*Pemerhatian*

Keamatan warna biru berkurangan/ Intensity of blue colour decreases//

larutan biru pudar/ Blue solution fades//

larutan biru bertukar kepada tak berwarna/ Blue solution turns colourless/

decolourise

Jelaskan

kepekatan ion kuprum(II)/ ion  $\text{Cu}^{2+}$  berkurangan

Concentration of copper(II) ion/  $\text{Cu}^{2+}$  ion decreases

.....[2M]

(iii) Copper(II) sulphate solution in cell P is replaced with dilute sulphuric acid. A colourless gas is produced at the cathode and the gas is collected. Describe one chemical test to identify the gas produced.

Larutan kuprum(II) sulfat dalam sel P digantikan dengan asid sulfurik cair. Gas tak berwarna dihasil pada katod dan dikumpulkan. Huraikan satu ujian kimia untuk mengenal pasti gas yang dihasilkan.

Place the burning splinter near the mouth of the test tube  
 Dekatkan kayu menyala di mulut tabung uji

Pop sound produce/ Bunyi ‘Pop’ terhasil

.....[2M]

[SPM2005-06] Jadual 6 menunjukkan penerangan dan pemerhatian bagi dua eksperimen, I dan II.

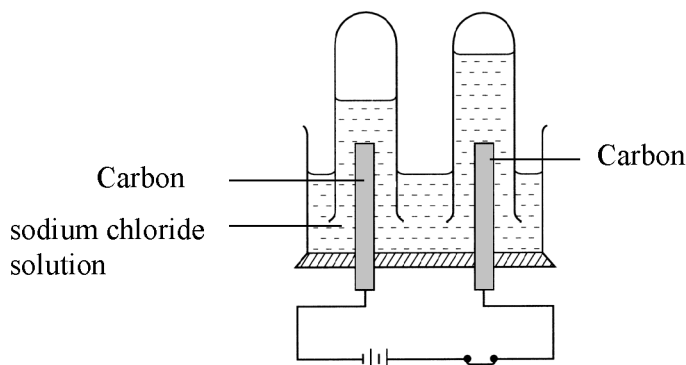
6. Table 6 shows the descriptions and observations for two experiments, I and II.

<b>Eksperimen</b> <i>Experiment</i>	<b>Penerangan</b> <i>Description</i>	<b>Pemerhatian</b> <i>Observation</i>
I	Elektrolisis larutan natrium sulfat 1 mol dm <sup>-3</sup> dengan menggunakan elektrod karbon. <i>Electrolysis of 1 mol dm<sup>-3</sup> Sodium sulphate solution using carbon electrodes.</i>	Gelembung gas terbebas di anod dan di katod <i>Gas bubbles are released at the anode and cathode</i>
II	Pembakaran 1.2 g serbuk magnesium dalam oksigen berlebihan. <i>Combustion of 1.2g of magnesium powder in excess oxygen.</i>	Nyalaan putih berkilau dan serbuk putih dihasilkan <i>Glaring white flame is seen and white powder is formed</i>

(a) Berdasarkan Eksperimen I/ Based on Experiment I :

(i) Lukiskan gambar rajah susunan radas untuk menjalankan eksperimen ini. Dalam gambar rajah anda tunjukkan bagaimana hasil di katod dan di anod dikumpulkan  
 Draw the set up of the apparatus to carry out this experiment.

In your diagram show how the products at the anode and cathode are collected. [3 M]



**3 Markah**

Markah 1- lukis dan berfungsi

Markah 2 – label – 2 elektrod dan elektrolit

Markah 3 – kaedah pengumpulan gas – tabung uji di pasang terbalik. [3M]

(ii) Nyatakan bagaimana anda mengesahkan bahawa gas yang terbebas di katod adalah hidrogen.

State how you would verify that the gas released at the cathode is hydrogen. [1M]

Place the burning splinter near the mouth of the test tube

Dekatkan kayu menyala di mulut tabung uji

Pop sound produce/ Bunyi ‘Pop’ terhasil

..... [1M]



(iii) Terangkan bagaimana gas hidrogen dihasilkan di katod.

*Explain how hydrogen gas is produced at the cathode. [3M]*

1. Ion H<sup>+</sup> ditarik/bergerak ke katod

*Hydrogen ions are attract to cathode*

2. Ion H<sup>+</sup> dinyachas// terima elektron membentuk atom hidrogen

*Hydrogen ion gain/ receive electron to formed hydrogen atom*

3. 2 atom hidrogen berpadu membentuk molekul hidrogen

*2 hydrogen atom combine with each other to formed hydrogen molecule*

..... [3M]

(b) Berdasarkan Eksperimen II/ *Based on Experiment II* :

(i) Serbuk putih yang dihasilkan ialah magnesium oksida. .... [1M]

Tuliskan formula magnesium oksida.

*The white powder formed is magnesium oxide. Write the formula for magnesium oxide.*

MgO

(ii) Tuliskan persamaan kimia bagi tindak balas yang berlaku.

*Write the chemical equation for the reaction that takes places. [1M]*



..... [2M]

(iii) Nyatakan nombor pengoksidaan bagi setiap unsur dalam sebatian magnesium oksida.

*State the oxidation number for each of the elements in magnesium oxide. [1M]*

(iii) nombor pengoksidaan magnesium = +2

*Oxidation number of Magnesium is +2*

nombor pengoksidaan oksigen = -2

*Oxidation number of Oxygen is -2*

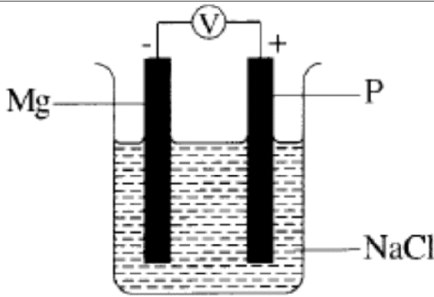
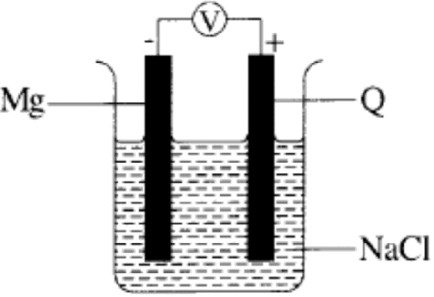
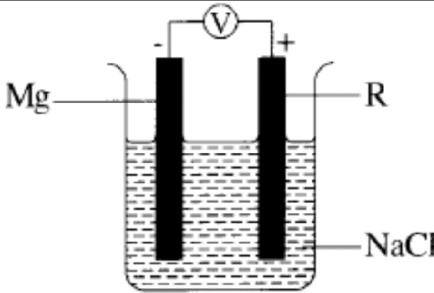
[no pengoksidaan – mesti tanda + or – kemudian diikuti oleh no]

..... [2M]

**[SPM2016-09]** Seorang pelajar ingin membina satu siri elektrokimia. Dia mengukur beza keupayaan bagi beberapa pasangan logam dalam Sel I, Sel II dan Sel III. Susunan radas yang digunakan dalam eksperimen dan nilai voltan ditunjukkan dalam Jadual 9.1.

*A student wants to construct an electrochemical series. He measures the potential differences of several pairs of metals in Cell 1, Cell II and Cell III. Apparatus set-up used in the experiment and the values of voltage are shown in Table 9.1.*

Sel Cell	Susunan radas Apparatus set-up	Voltan (V) Voltage (V)
-------------	-----------------------------------	---------------------------

I		X
II		Y
III		Z

(a) Nilai Z lebih besar daripada nilai Y dan nilai Y lebih besar daripada nilai X.  
*The value of Z is greater than the value of Y and the value of Y is greater than the value of X.*

(i) Susun logam P, Q, R dan magnesium dalam tertib menurun siri elektrokimia. Terangkan jawapan anda. [5 markah]  
*Arrange the metals P, Q, R and magnesium in descending order of electrochemical series. Explain your answer. [5 marks]*

Susun : Mg, P, Q, R

Penerangan:

1. Mg terletak di atas logam P, Q dan R dalam siri elektrokimia kerana Mg adalah terminal negatif.  
*Mg located above metal P, Q and R in the electrochemical series because Mg is negative terminal*
2. P terletak di bawah Mg kerana nilai X adalah paling kecil  
*P located below Mg because the value of X is the smallest*
3. Q terletak di bawah P kerana nilai Y lebih kecil daripada nilai X  
*Q located below P because the value of Y is the greater than the vale of X*
4. R terletak di bawah Q kerana nilai Z adalah paling besar.  
*R located below Q because the value of Z is the greatest*

(ii) Cadangkan logam yang sesuai sebagai P, Q dan R.

Tulis setengah persamaan pada terminal positif dan terminal negatif dalam Sel I.

[5 markah]

*Suggest the metals that are suitable as P, Q, and R.*

*Write the half equations at the positive terminal and the negative terminal in Cell I.*

[5 marks]

P : Aluminium/ Aluminium

Q : Zink/ zinc

R : kuprum/ copper

Setengah persamaan/ Half equation

Katod//Terminal positif:  $2\text{H}^+ + 2\text{e} \rightarrow \text{H}_2$

Cathode// Positive terminal

Anod// Terminal negatif:  $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}$

Anode// Negative terminal

(b) Seorang pelajar telah menjalankan satu eksperimen untuk mengkaji salah satu faktor yang mempengaruhi elektrolisis.

Jadual 9.2 menunjukkan pemerhatian bagi dua set eksperimen. Kedua-dua eksperimen itu menggunakan elektrod karbon.

*A student carried out an experiment to study one of the factors affecting electrolysis. Table 9.2 shows the observations for two sets of experiment. Both of the experiment use carbon electrodes.*

Eks	Katod/ Cathode	Anod /Anode
Set I	Gelembung gas tanpa warna terbebas <i>Colourless gas bubbles released</i>	Gelembung gas kuning kehijauan terbebas <i>Greenish yellow gas bubbles released</i>
Set II	Gelembung gas tanpa warna terbebas <i>Colourless gas bubbles released</i>	Gelembung gas tanpa warna terbebas <i>Colourless gas bubbles released</i>

Dengan menggunakan elektrolit yang sesuai, huraikan satu eksperimen yang dapat dijalankan bagi memperoleh pemerhatian seperti dalam Jadual 9.2.

Huraian anda haruslah mengandungi perkara berikut:

(i) Susunan radas

(ii) Prosedur

(iii) Setengah persamaan di anod dan katod

[10 markah]

*By using a suitable electrolyte, describe an experiment that can be carried out to obtain the observation as in Table 9.2.*

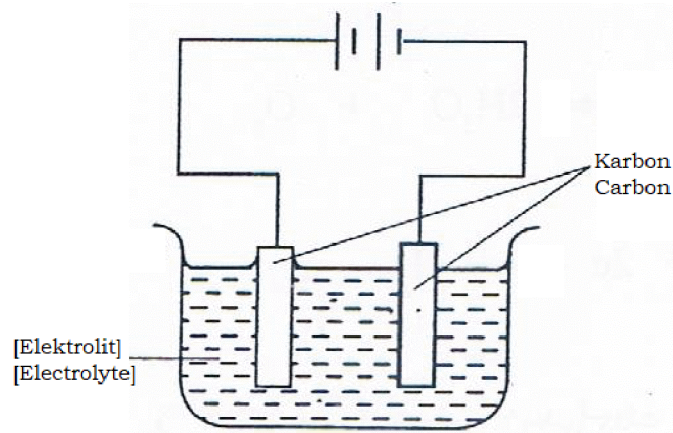
*Your description should include the following:*

(i) Apparatus set-up

(ii) Procedure

(iii) Half equations at the anode and cathode

[10 marks]



### Prosedur

3. isi bikar/ sel elektrolisis dengan asid hidroklorik/ larutan natrium klorida 1.0 mol dm<sup>-3</sup>/ pekat (atau mana-mana elektrolit yang sesuai)

*Fill the beaker/ eletrolytic cell with 1.0 mol dm<sup>-3</sup>/ concentrated hydrochloric acid/ sodium chlorida solution [or any suitable electrolyte]*

4. celup elektrod karbon ke dalam bikar// telangkup tabung uji berisi [elektrolit] ke atas elektrod

*dip carbon electrodes into the beaker// invert test tube filled [electrolyte] over the electrode*

5. sambungkan elektrod kepada bateri dengan wayar penyambung// lengkapkan litar// hidupkan litar

*connect the electrodes to the battery with connecting wire// complete the circuit// swithc on*

6. ulang langkah 1 hingga 3 menggunakan 0.001 mol dm<sup>-3</sup> asid hidroklorik/ larutan natrium klorida (atau mana-mana elektrolit yang sesuai)

*Repeat step 1 to 3 using 0.001 mol dm<sup>-3</sup> / dilute hydrochloric acid/ sodium chloride solution (or any suitable elektrolyte)*

### Persamaan setengah// Half eqaution

#### **Set I**

Anod/ Anode :  $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}$

Katod/ cathode :  $2\text{H}^+ + 2\text{e} \rightarrow \text{H}_2$

#### **Set II**

Anod/ Anode :  $4\text{OH}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}$

Katod/ cathode :  $2\text{H}^+ + 2\text{e} \rightarrow \text{H}_2$

[SPM2019-09] (a) Diagram 7 shows the apparatus set-up used to study the factor that affects the products of electrolysis of an aqueous solution W.

Rajah 7 menunjukkan susunan radas yang digunakan untuk mengkaji faktor yang mempengaruhi hasil elektrolisis larutan akueus W.

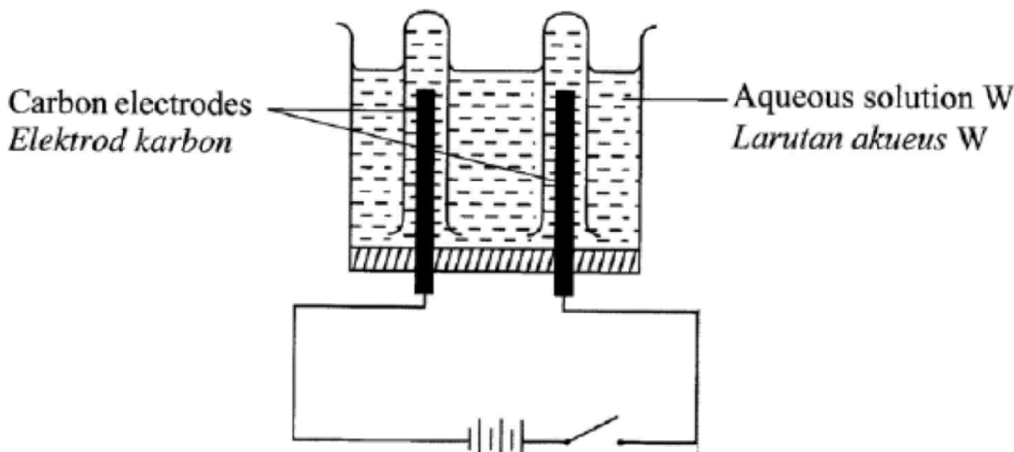


Table 5.1 shows the results obtained from two sets of experiment using aqueous solution W.

Jadual 5.1 menunjukkan keputusan yang diperoleh daripada dua set eksperimen yang menggunakan larutan akueus W.

Set	Observation at the anode Pemerhatian di anod	Observation at the cathode Pemerhatian di katod
I	Greenish yellow gas is released Gas kuning kehijauan dibebaskan	Colourless gas is released Gas tidak berwarna dibebaskan
II	Colourless gas is released Gas tidak berwarna dibebaskan	Colourless gas is released Gas tidak berwarna dibebaskan

Based on Table 5.1 suggest one suitable aqueous solution W. Compare and contrast the observation on the products formed and explain your answer.

[6 marks]

Berdasarkan Jadual 5.1 cadangkan satu larutan akueus W yang sesuai. Banding dan beza pemerhatian bagi basil yang terbentuk dan terangkan jawapan anda.

[6 markah]

1. Potassium chloride solution // larutan kalium klorida// KCl  
 any suitable chloride salt solution//  
 Asid Hidroklorik// Hydrochloric acid// HCl

Set	Set I	Set II
Anode Anod	Chlorine gas Gas klorin	Oxygen gas Gas oksigen
Cathode Katod	Hydrogen gas Gas hidrogen	Hydrogen gas Gas hidrogen

#### Anode

Set 1 : Chloride ion is discharged because it more concentrated than hydroxide ion H//

Ion klorida dinyahcas kerana kepekatannya lebih tinggi daripada ion hidroksida



Set II : Hydroxide ion is discharged because it is lower than chloride ion in the electrochemical series //

Ion hidroksida dinyahcaskan kerana kedudukannya lebih rendah daripada ion klorida dalam siri elekirokimia

Cathode

Hydrogen ion is discharged because it is lower than potassium ion in the electrochemical series //

Ion hydrogen dinyahcaskan kerana kedudukannya lebih rendah daripada ion kalium dalam siri elekirokimia

(b) By using the aqueous solution W suggested in 9(a), state the ions present and write the half equations at the anode and the cathode in both Set I and Set II. [4 marks]

Dengan menggunakan larutan akueus W yang dicadangkan dalam 9(a), nyatakan ion yang hadir dan tulis setengah persamaan di anod dan katod dalam kedua-dua Set I dan Set II. [4 markah]

K<sup>+</sup>, H<sup>+</sup>, Cl<sup>-</sup>, OH<sup>-</sup>

	Anode Anod	Cathode Katod
Set I	$2Cl^- \rightarrow Cl_2 + 2e$	$2H^+ + 2e \rightarrow H_2$
Set II	$4OH^- \rightarrow 2H_2O + O_2 + 4e$	$2H^+ + 2e \rightarrow H_2$

(c) Table 5.2 shows the results of the experiment to determine the positions of metal A, metal B and metal C in electrochemical series.

Jadual 5.2 menunjukkan keputusan bagi eksperimen untuk menentukan kedudukan logam A, logam B dan logam C dalam siri elektrokimia.

<b>Metal Logam</b> <b>Solution Larutan</b>	A	B	C
Solution A Larutan A		✗	✓
Solution B Larutan B	✓		✓
Solution C Larutan C	✗	✗	

<https://cikguadura.wordpress.com/>

Based on Table 5.2, arrange metals A, B and C according to the ascending order of electropositivity and suggest the metals A, B, C and their respective nitrate salt solutions. Describe an experiment to show how you obtain the result of the experiment as shown in Table 5.2. Your description should include:

- (i) Apparatus and materials
- (ii) Procedures [10 marks]

Berdasarkan Jadual 5.2, susun logam A, B dan C berdasarkan keelektropositifan secara tertib menaik dan cadangkan logam A, B, C dan larutan garam nitrat masing-masing. Huraikan satu eksperimen untuk menunjukkan bagaimana anda memperoleh keputusan bagi eksperimen seperti yang ditunjukkan dalam Jadual 5.2. Huraian anda perlu mengandungi:

- (i) Radas dan bahan
- (ii) Prosedur [10 markah]

Susunan : B , A , C

B= Cu

A = Zn

C = Mg

A : Zn, Solution :  $\text{Zn}(\text{NO}_3)_2$

B : Cu, Solution :  $\text{Cu}(\text{NO}_3)_2$

C : Mg, Solution :  $\text{Mg}(\text{NO}_3)_2$

#### Apparatus

Test tube / test tube rack / sand paper //

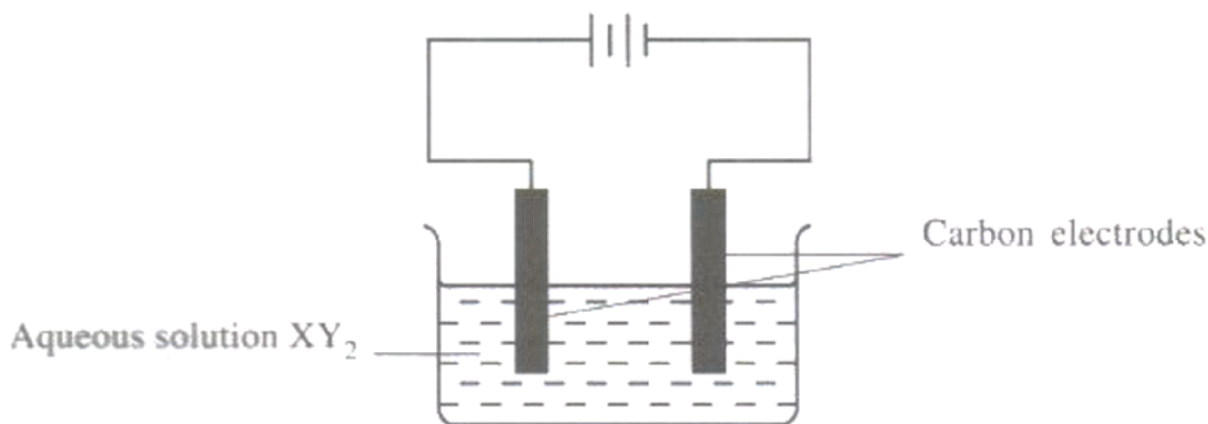
Tabung uji / rak tabung uji / kertas pasir

#### Procedure

1. Clean metals A, B and C // Bersihkan logam A, B dan C.
2. Pour [2 cm<sup>3</sup> of solution A] into three different test tubes //  
Tuang [2 cm<sup>3</sup> larutan A] ke dalam tiga tabung uji yang berlainan
3. Put [ Metal A], [Metal B] and [ Metal C] //  
Letak [Logam A], [logam B] dan [ Logam C]
4. Record observations // Catat pemerhatian
5. Repeat steps 1 - 4 using [Solution B] and [Solution C] //  
Ulang langkah 1-4 dengan menggunakan [ Larutan B] dan [Larutan C]

**[SPM2010-09]** Diagram 9 shows the apparatus set-up for the electrolysis 1.0 mol dm<sup>-3</sup> aqueous solution of compound XY<sub>2</sub>.

Rajah 9 menunjukkan susunan radas untuk menjalankan elektrolisis bagi larutan akueus bagi sebatian XY<sub>2</sub>, 1.0 mol dm<sup>-3</sup>.



(a) Suggest one possible cation for  $X^{2+}$  ion. Using your knowledge of factors affecting the selective discharge of ions at the electrodes,  
 Cadangkan **satu** kation yang mungkin bagi ion  $X^{2+}$ . Dengan menggunakan pengetahuan anda tentang faktor-faktor yang mempengaruhi pemilihan ion untuk dinyahcaskan di elektrod,

**Letakkan ion**

Ion  $Cu^{2+}$  // Copper(II) // Copper ion

Cadangan lain/ Other suggestion answer :

Ion zink/ Zinc ion /  $Zn^{2+}$  //

Magnesium/  $Mg^{2+}$  //

Ion ferum(II) // Iron(II) ion /  $Fe^{2+}$  //

ion plumbum(II) // Lead(II) ion /  $Pb^{2+}$  //

Barium //  $Ba^{2+}$  //

Ion Kalsium // Calcium ion /  $Ca^{2+}$

(i) Write the half equation for the reaction at the cathode.

Tulis setengah persamaan bagi tindak balas di katod,

[3M]

Persamaan setengah/ Half equation:



Selain itu/ other:



(ii) State the type of reaction at the cathode.

nyatakan jenis tindak balas di katod.

[1M]

Penurunan // Reduction

(b) Suggest one possible anion for  $Y^-$  ion. Name the product at the anode and explain the formation of the product. Describe one chemical test for the product.  
 Cadangkan **satu** anion yang mungkin bagi ion  $Y^-$ . Namakan hasil pada anod dan terangkan pembentukan hasil itu. Huraikan **satu** ujian kimia untuk hasil itu. [6M]

Suggestion ion: nitrate //  $NO_3^-$

Cadangan ion: nitrat/  $NO_3^-$

Nama hasil: gas oksigen  
Name the product : oxygen gas

**explain the formation of the product**

1. OH- dipilih untuk didiskas/ nyahcas  
OH- selected for discharge
2. OH- is lower than  $\text{NO}_3^-$  in ECS  
OH- adalah lebih rendah daripada  $\text{NO}_3^-$  dalam SEK

**Describe one chemical test for the product.**

1. letak kayu uji berbara ke dalam tabung uji yang mengandungi gas  
place a glowing splinter into the test tube
2. kayu uji berbara menyala// gas menyalakan kayu uji berbara  
the splinter rekindles/ lights up

(c) A student intends to electroplate an iron spoon with silver to make it more attractive. Plan one laboratory experiment to electroplate the iron spoon. Your answer should include the following:

- A list of material and apparatus
- Procedure of the experiment
- A labelled diagram showing the apparatus set-up
- The half equations for the reactions at the anode and the cathode

Seorang murid ingin menyadur satu sudu besi dengan argentum untuk menjadikan sudu itu lebih menarik. Rancang satu eksperimen makmal untuk menyadur sudu besi itu. Jawapan anda perlu mengandungi perkara berikut:

- Senarai bahan dan radas
- Prosedur eksperimen
- Gambar rajah berlabel yang menunjukkan susunan radas
- Setengah persamaan bagi tindak balas di anod dan di katod

[10M]

1 Sudu besi/ plat argentum/ wayar/ sel / bikar/ larutan argentum nitrat/ bateri  
Iron spoon/ silver plate/ wire/ cells/ beaker/ silver nitrate solution/ battery

2. Bersihkan sudu besi  
Clean the iron spoon

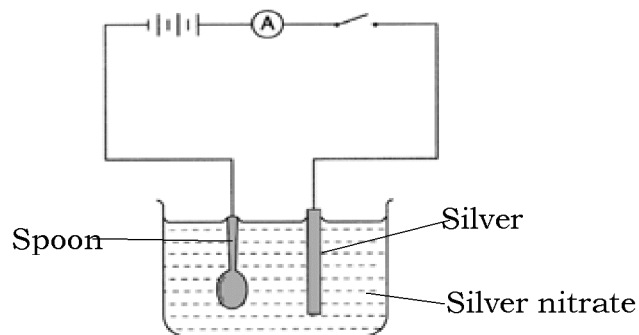
3. Tuangkan larutan argentum nitrat ke dalam bikar  
Pour silver nitrate solution into a beaker

4. Gunakan plat argentum sebagai anod// sudu besi sebagai katod  
Use silver plate as anode// iron spoon as cathode

5. kedua-dua elektrod direndam di dalam elektrolit/ larutan  
Both electrodes are immersed in the electrolyte

6. suis ditutup untuk melengkapkan litar  
The switch is closed to complete the circuit

**Diagram**



functional diagram : batteries, wire, metal plate, spoon both immersed half in electrolyte and solution is dash line

labels : spoon must connect to correct terminal

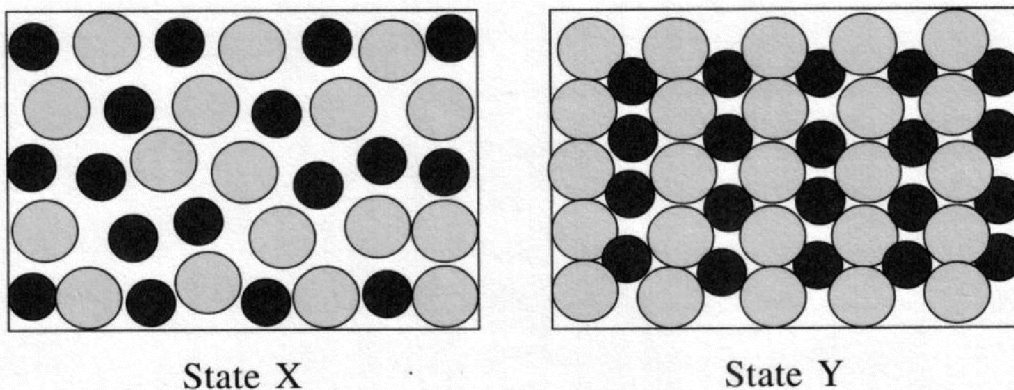
Persamaan setengah/ Half equation

Di katod/ at cathode :  $\text{Ag}^+ + e \rightarrow \text{Ag}$

Di anod/ at anode :  $\text{Ag} \rightarrow \text{Ag}^+ + e$

**[SPM2006-10]** Sebatian ini boleh mengalirkan arus elektrik dalam keadaan X dan tidak boleh mengalirkan arus elektrik dalam keadaan Y.

Diagram 10 shows the arrangement of particles of a compound in two different states, X and Y.



(a) Sebatian ini boleh mengalirkan arus elektrik dalam keadaan X dan tidak boleh mengalirkan arus elektrik dalam keadaan Y. Namakan satu contoh sebatian yang mempunyai sifat ini.

The compound can conduct electricity in state X but cannot do so in state Y. Name **one** example of a compound with this property. [1M]

**Catatan: larutan dan lain-lain yang sesuai kecuali yang terurai bila dipanaskan.**

Natrium klorida// sodium chloride

Natrium iodide// sodium iodide

Plumbum(II) bromide// lead(II) bromide



Plumbum(II) oksida// lead(II) oxide  
 Kalium iodide// potassium iodide  
 Kalium bromide// potassium bromide  
 Zink iodide// zinc iodide  
 Aluminium oksida// aluminium oxide  
 Ferum oksida// iron oxide  
 Magnesium bromide// magnesium bromide  
 Magnesium klorida// magnesium chloride

(b) Tulis satu daripada dua setengah persamaan bagi elektrolisis sebatian yang dinamakan di 10(a). [3M]

Write **one** of the two half equation for the electrolysis of the compound you named in 10(a).

Jika natrium klorida// sodium chloride

At anode:  $2\text{Cl}^- \rightarrow \text{Cl}_2 + 2\text{e}^- //$

At cathode:  $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$

Jika plumbum(II) bromide// lead(II) bromide

anod:  $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$

Katod:  $\text{Pb}^{2+} + 2\text{e}^- \rightarrow \text{Pb}$

(c) Lukis satu rajah susunan radas berlabel yang anda dapat gunakan untuk mengelektrolisis sebatian yang dinamakan di 10(a). Dalam lukisan anda, tunjukkan dengan anak panah pergerakan zarah-zarah yang berlaku di dalam sebatian itu.

Draw a labelled diagram of the apparatus that you can use to electrolyse the compound you named in 10(a). In your drawing, show by using arrows the movement of particles that occurs in the compound. [10M]

1 simbol sumber tenaga elektrik/ symbol of power source

2 dawai penyambung/ connecting wire

3 elektrod/ electrode

4 label nama elektrod yang sesuai (karbon/platinum)/ label of the name of the electrode

5 elektrolit dalam bekas/ electrolyte in container

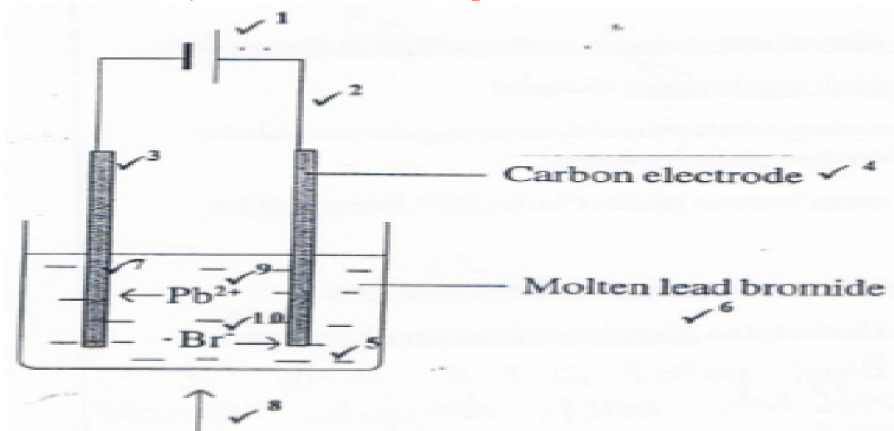
6 label elektrolit (nama/ formula)/ label of the name of the electrolyte

7 elektrod terendam dalam elektrolit yang sama/ electrode is dipped in the electrolyte

8 simbol/ label pemanasan/ panaskan// penunu/ symbol/ label of heating

9 pergerakan zarah kation ke katod mesti tunjuk dengan anak panah/ movement of cation particle to the cathode

10 pergerakan zarah anion ke anod /movement of anion particle to the anode



(d) Huraikan proses elektrolisis yang berlaku di 10(c).  
*describe the electrolysis process that occurs in 10 (c). [6M]*

1 Anion/ ion yang bercas negatif iaitu ion Br<sup>-</sup> bergerak ke anod  
*The negatively charged anion, Br<sup>-</sup> moves towards anode*

2 ion Br<sup>-</sup> dinyahcas dengan melepaskan electron dan membentuk gas bromin di anod  
*Br<sup>-</sup> is discharged by releasing electron and forms bromine gas at the anode*

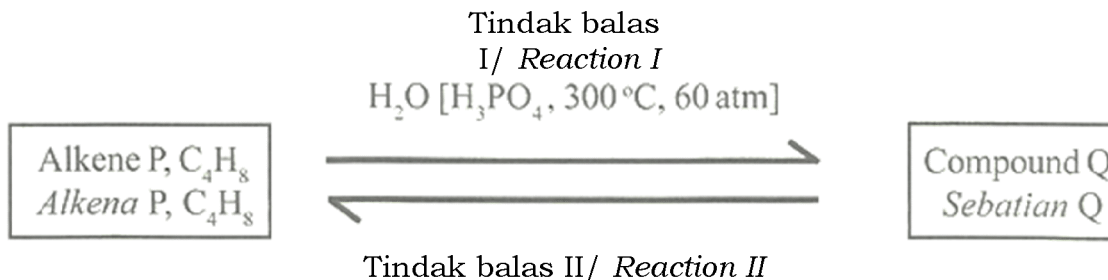
3 elektron yang telah dinyahkan mengalirkan semula ke bateri dan mengalir ke katod  
*the discharged electron flows back to the battery and moves to the cathode*

4 Kation/ ion yang bercas positif iaitu Pb<sup>2+</sup> bergerak ke katod  
*The positively charged cation, Pb<sup>2+</sup> moves to catode*

5. Pb<sup>2+</sup> dinyahcas dengan menerima electron daripada katod dan membentuk atom plumbum  
*Pb<sup>2+</sup> is discharged by receiving electrons from the cathode to form lead atom*

**Bab 10**

**[SPM2013-05]** Rajah 5 menunjukkan alkena P,  $C_4H_8$  melalui tindak balas I membentuk sebatian Q, Sebatian Q melalui tindak balas II membentuk alkena P. Diagram 5 shows alkene P,  $C_4H_8$  undergoes reaction I to form compound Q. Compound Q undergoes reaction II to form alkene P.

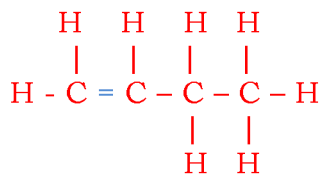


Rajah 5/ Diagram 5

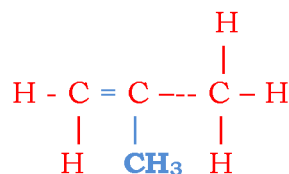
(a) Nyatakan nama bagi alkena P,  $C_4H_8$ .....[1M]  
 State the name for alkene P,  $C_4H_8$

*Butena/ butene*

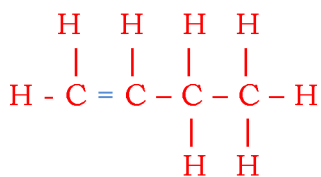
(b) Lukis formula struktur untuk dua isomer bagi alkena P,  $C_4H_8$   
 Draw the structural formulae for two isomers of alkene P,  $C_4H_8$



*But-1-ena/but-1-ene*



*2-metilpropena/ 2-methylpropene*



*But-1-ena / But-1-ene*

[2M]

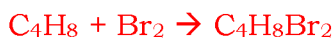
(c) (i) Nyatakan pemerhatian apabila alkena P dialirkan melalui air bromin.  
 State the observation when alkene P is passed through into bromine water.

*Brown colour of bromine water turn to colourless*

*Warna Perang air bromin menjadi tidak berwarna*

.....[1M]

(ii) Tuliskan persamaan kimia seimbang bagi tindak balas dalam 5(c)(i).  
 Write the balanced chemical equation for the reaction in 5(c)(i).



.....[2M]

Berdasarkan Rajah 5:/ Based on Diagram 5:

(i) Nyatakan nama bagi sebatian Q. ....[1M]  
 State the name of compound Q.

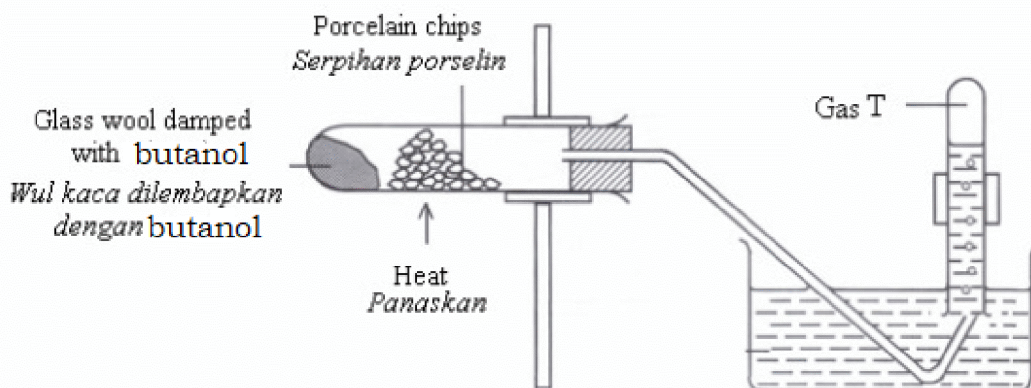
butanol

(ii) Tulis persamaan kimia seimbang bagi penukaran alkena P kepada sebatian Q dalam tindak balas I.  
 Write the balanced chemical equation for the conversion of alkene P to compound Q in reaction I.



.....[2M]

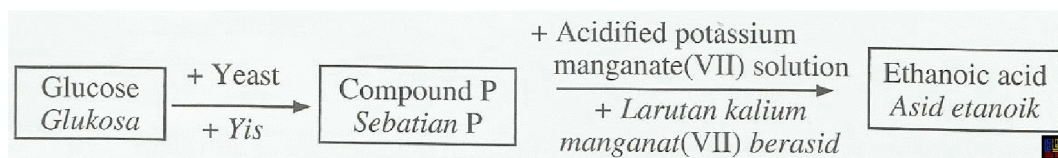
Lukis rajah berlabel bagaimana tindak balas II dijalankan dalam makmal.  
 Draw a labelled diagram how reaction II can be carried out in the laboratory.



[2M]

[SPM2018-06] (a) Diagram 6.1 shows a flow chart for the formation of ethanoic acid starting from glucose.

Rajah 6.1 menunjukkan satu carta alir bagi pembentukan asid etanoik bermula daripada glukosa.



(i) State the process to produce compound P.  
 Nyatakan proses untuk menghasilkan sebatian P.

Penapaian/ Fermentation

..... [1M]

(ii) State the name of compound P. .... [1M]  
 Nyatakan nama bagi sebatian P.

etanol

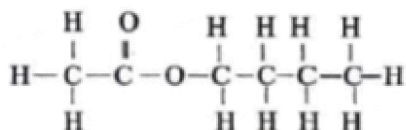
(iii) Write a chemical equation for the formation of compound P from glucose.  
 Tulis satu persamaan kimia bagi pembentukan sebatian P daripada glukosa.



..... [2M]

(b) Reaction between ethanoic acid and butanol produces ester Q.  
Tindak balas antara asid etanoik dengan butanol menghasilkan ester Q.

(i) Draw the structural formula of ester Q in the space provided below.  
Lukis formula struktur bagi ester Q dalam ruang yang disediakan di bawah



**Butil Etanoat**

(ii) Describe briefly the preparation of ester Q in a laboratory.  
Huraikan secara ringkas penyediaan ester Q dalam makmal

**Campur asid etanoik dengan butanol dalam tabung didih**  
**Mix ethanoic acid with buthanol in a boiling tube.**

**Tambahkan H<sub>2</sub>SO<sub>4</sub> pekat**  
**Add concentrated H<sub>2</sub>SO<sub>4</sub>**

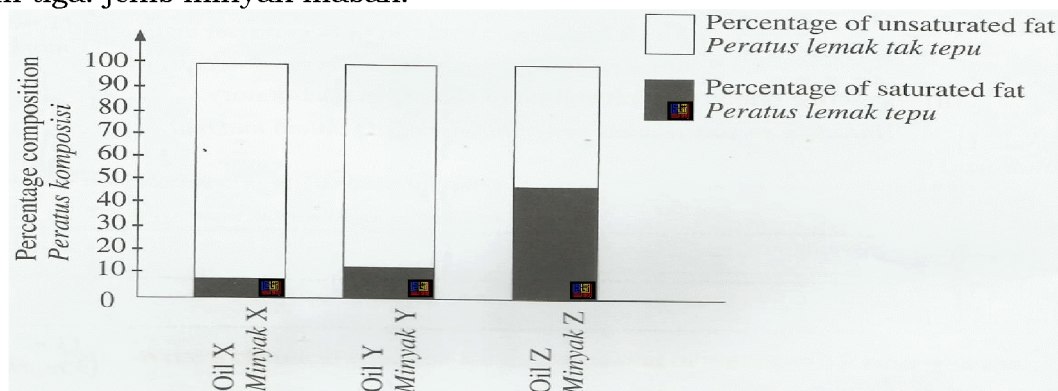
**Heat// panaskan**

..... [3M]

(c) Deep frying involves the process of submerging food in hot oil. At high temperature, the molecule of oil that contain double bonds tend to react with oxygen to form harmful compound which is carcinogenic.  
Goreng minyak penuh melibatkan proses merendam makanan dalam minyak panas. Pada suhu tinggi, molekul minyak yang mengandungi ikatan ganda dua cenderung untuk bertindak balas dengan oksigen untuk menghasilkan sebatian berbahaya yang bersifat karsinogen.

Diagram 6.2 shows the percentage composition of saturated and unsaturated fats in three types of cooking oils.

Rajah 6.2 menunjukkan peratus komposisi bagi lemak tepu dan lemak tak tepu dalam tiga jenis minyak masak.





Based on Diagram 6.2,/ Berdasarkan Rajah 6.2,

(i) Which cooking oil is most suitable for deep frying at high temperature?  
Minyak masak manakah yang paling sesuai untuk goreng minyak penuh pada suhu tinggi?

Minyak/ oil Z

..... [1M]

(ii) Explain your answer in 6(c)(i)./ Jelaskan jawapan anda dalam 6(c) (i).

Z oil has more percentage of saturated fat/

Minyak Z mempunyai peratusan lemak tak tepu yang tinggi

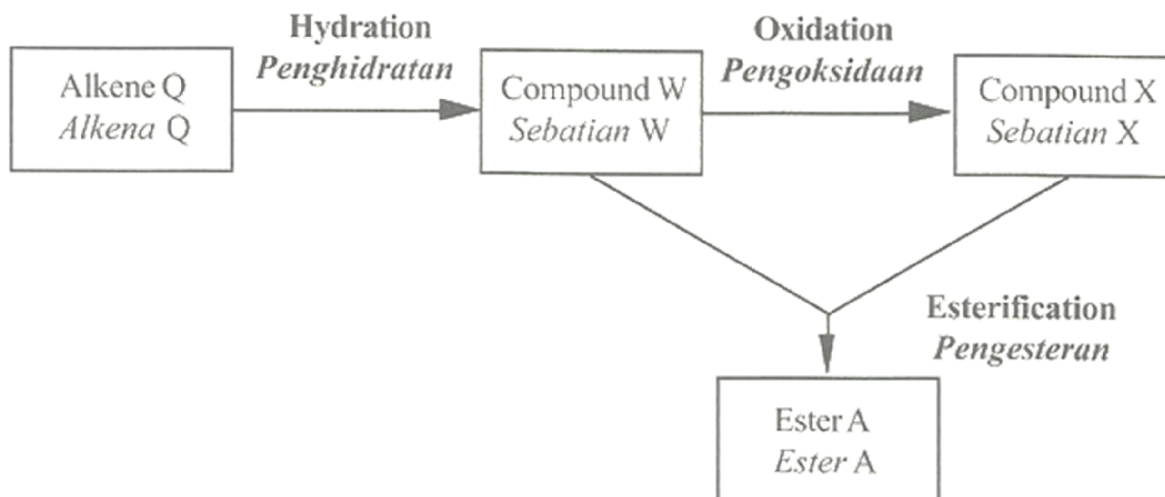
Less oxidation occurred/

Kurang mengalami pengoksidaan

..... [2M]

**[SPM2013-09]** Rajah 9 menunjukkan penukaran sebatian organik daripada satu siri homolog kepada yang lain.

Diagram 9 shows the conversion of an organic compound from one homologous series to another.



(a) Jisim molekul relatif yang mungkin bagi alkena Q adalah 28, 42 atau 56. Dengan memilih salah satu daripada jisim molekul relatif itu, tentukan formula molekul bagi alkena itu lukiskan formula struktur dan nyatakan nama bagi alkena itu. [Jisim atom relatif: H=1; C=12] [4M]

The possible relative molecular masses of alkene Q are 28, 42 or 56. By choosing any one of the relative molecular masses, determine the molecular formula for the alkene draw the structural formula and state the name of the alkene. [Relative atomic mass: H=1; C=12] [4M]

Pengiraan/ calculation

$$C_nH_{2n} = 28$$

$$2(12)+2n(1) = 28$$

$$12n+2n= 28$$

$$n= 28/14$$

$$n=2$$

Molecular formula =  $C_2H_4$

$C_nH_{2n} = 42$

$n=3$

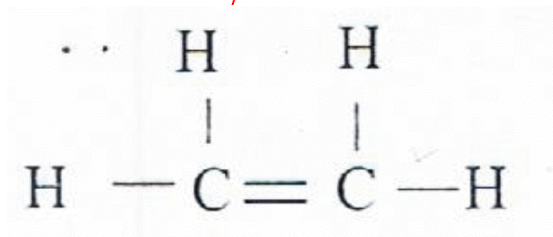
$C_3H_6$

$C_nH_{2n} = 56$

$n=4$

$C_4H_8$

Contoh : Etena/ ethene

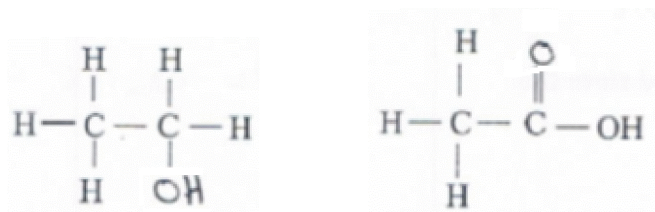


(b) Berdasarkan Rajah 9 dan jawapan yang diperoleh dari 9(a), lukiskan formula struktur dan nyatakan nama sebatian W dan sebatian X. Tuliskan persamaan kimia untuk menunjukkan penukaran sebatian W kepada sebatian X. [6M]

*Based on Diagram 9 and answer that obtained from 9(a), draw the structural formulae and state the names of compound W and compound X. write the chemical equation to show the conversion of compound W to compound X. [6M]*

Etanol/ ethanol

Asid etanoik/ ethanoic acid



Persamaan/ equation

$C_2H_5OH + 2[O] \rightarrow CH_3COOH + H_2O$

(c) Dengan menggunakan sebatian W dan sebatian X yang diperoleh di 9(b), huraikan bagaimana ester A boleh disediakan di makmal. Dalam huraian anda, sertakan:

- Senarai bahan dan radas
- Prosedur
- Pemerhatian
- Persamaan kimia
- Nama bagi ester A

[10M]

*By using compound W and compound X that obtained in 9(b), describe how ester A can be prepared in the laboratory. In your description, include:*

*List of materials and apparatus*

- *Procedure*
- *Observations*
- *Chemical equation*
- *Name of ester A*

[10M]

*List of apparatus and materials*

1. etanol, asid etanoik, asid sulfurik, air, tabung didih, kelalang dasar bulat, bikar [bekas yang sesuai]  
Ethanol, ethanoic acid, sulphuric acid, water, boiling tube, round bottom flask, beaker [suitable container]

*Procedure*

2. sukat [2- 50] cm<sup>3</sup> etanol tulen

Measure [2 – 50] cm<sup>3</sup> absolute/ pure ethanol

3. tuang etanol ke dalam tabung didih/kelalang dasar bulat

Pour ethanol into a boiling tube/ round bottom flask

4. sukat [2-50]cm<sup>3</sup> asid etanoik glasial

Measure [2-50] cm<sup>3</sup> glacial ethanoic acid

5. tambah asid etanoik kepada etanol

Add ethanoic acid to ethanol

6. tambah asid sulfurik pekat

Add concentrated sulphuric acid

7. panaskan perlahan-lahan/ refluk campuran

Heat slowly/ reflux the mixture

8. tuang campuran ke dalam bikar berisi air, bau harum terhasil

Pour the mixture into a beaker of water, sweet smell produce

9/10. Persamaan/ equation



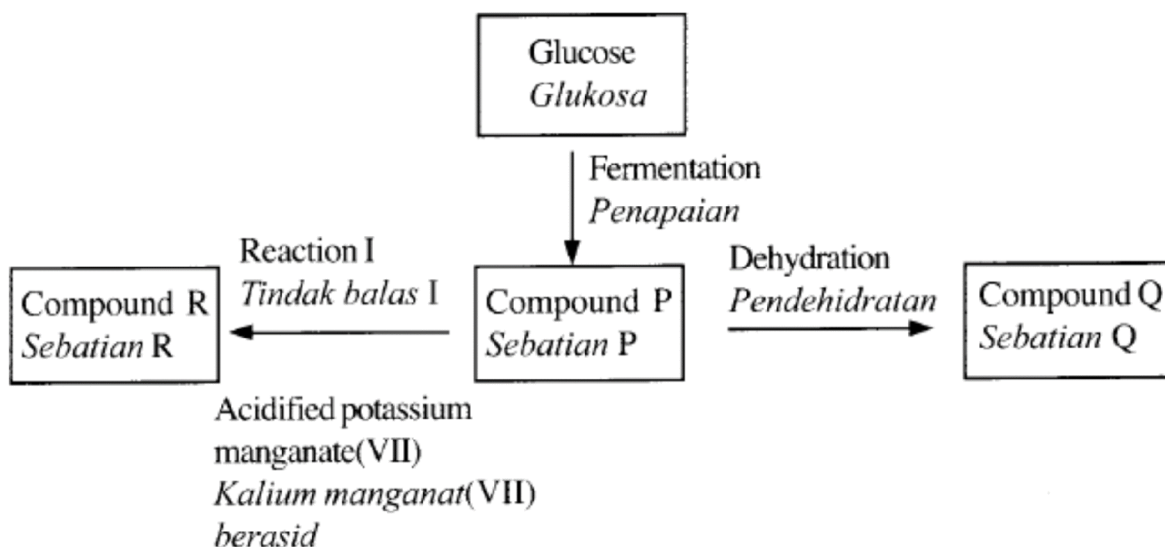
*Name of ester*

11. Etil etanoik/ Ethyl ethanoate

**[SPM2016-07b]**(b) Rajah 1 menunjukkan penukaran sebatian P kepada sebatian Q dan sebatian R. Sebatian P adalah cecair tidak berwarna yang boleh dihasilkan melalui penapaian glukosa.

*Diagram 7 shows the conversion of compound P into compounds, Q and R.*

*Compound P is a colourless liquid that can be produced from the fermentation of glucose.*



- (i) Nyatakan nama bagi Tindak balas I dan kenal pasti siri homolog, formula molekul dan formula struktur bagi sebatian P, sebatian Q dan sebatian R. [10M]  
 State the name of Reaction I and identify the homologous series, molecular formulae and structural formulae of compounds, P, Q and R. [10 marks]

Tindak balas I: Pengoksidaan  
 Reaction I: Oxidation

aspek <i>aspect</i>	Sebatian P <i>Compound P</i>	Sebatian Q <i>Compound Q</i>	Sebatian R <i>Compound R</i>
Siri homolog <i>Homologous series</i>	Alkohol <i>alcohol</i>	alkena <i>alkene</i>	Asid karboksilik <i>Carboxylic acid</i>
Formula molekul <i>Molecular formula</i>	$C_2H_5OH$	$C_2H_4$	$CH_3COOH$
Formula struktur <i>Structural formula</i>	$\begin{array}{c} H & H \\   &   \\ H-C & -C-OH \\   &   \\ H & H \end{array}$	$\begin{array}{c} H & H \\   &   \\ H-C & =C-H \end{array}$	$\begin{array}{c} H & O \\   &    \\ H-C & -C-OH \\   \\ H \end{array}$

- (ii) Hitung isi padu gas karbon dioksida yang terhasil apabila 7.0g sebatian Q dibakar dalam oksigen berlebihan. [Jisim atom relatif: H=1; C = 12; O=16]  
 [1 mol gas menempati 24 dm<sup>3</sup> pada keadaan bilik] [6 markah]  
 Calculate the volume of carbon dioxide gas produced when 7.0 g of compound Q is burnt in excess oxygen. [Relative atomic mass: H=1; C=12; O=16]  
 [1 mole of gas occupies 24 dm<sup>3</sup> at room conditions] [6 marks]



Jisim molar sebatian Q = 2(12) + 4(1) = 28  
 Molar mass of compound Q

Bilangan mol sebatian Q =  $7/28 = 0.25$

*Number of mole of compound Q*

1 mol sebatian Q menghasilkan 2 mol gasCO<sub>2</sub>

0.25 mol sebatian Q menghasilkan 0.5 mol gasCO<sub>2</sub>

*1 mol of compound Q produces 2 mol of CO<sub>2</sub>*

*0.25 mol of compound Q produces 0.5 mol of CO<sub>2</sub>*

Isi padu gas CO<sub>2</sub> =  $0.5 \times 24 = 12 \text{ dm}^3$

*Volume of CO<sub>2</sub>*

## Bab 11

[SPM2005-05] (a) Apakah yang dimaksudkan dengan *haba pembakaran alcohol*?

*What is the meaning of the heat of combustion of an alcohol? [1 M]*

**haba yang dibebaskan apabila satu mol bahan dibakar dengan lengkap dalam oksigen, O<sub>2</sub> berlebihan.**

**heat released when 1 mole of a substance is completely burnt in excess oxygen, O<sub>2</sub>.**

[1 markah]

(b) Jadual 5 menunjukkan haba pembakaran tiga jenis alkohol.

Bilangan atom karbon dan daya tarikan antara molekul adalah antara faktor-faktor yang mempengaruhi nilai haba pembakaran.

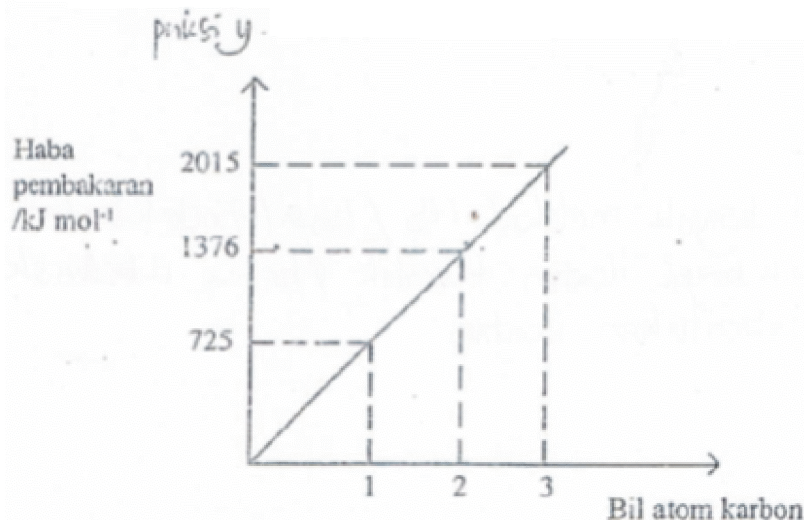
*Table 5 shows the heat of combustion of three types of alcohol.*

*The number of carbon atoms and the attractive force between molecules are among the factors that affect the value of heat of combustion.*

<b>Nama alkohol</b> <i>Name of alcohol</i>	<b>Formula molekul</b> <i>Molecular formula</i>	<b>Haba pembakaran /kJ mol<sup>-1</sup></b> <i>Heat of combustion /kJ mol<sup>-1</sup></i>
Metanol <i>Methanol</i>	CH <sub>3</sub> OH	725
Etanol <i>Ethanol</i>	C <sub>2</sub> H <sub>5</sub> OH	1376
Propanol <i>Propanol</i>	C <sub>3</sub> H <sub>7</sub> OH	2015

(i) Gunakan data dalam Jadual 5 untuk **melukis graf** haba pembakaran melawan bilangan atom karbon pada kertas graf di muka sebelah.

*Use data from Table 5 to **draw the graph** of the heat of combustion against number of carbon atoms on the graph paper below. [2M]*



- all points** are transferred correctly
- draw a **straight line**

(ii) Berdasarkan pada graf di (b)(i), apabila bilangan atom karbon bertambah, nilai haba pembakaran juga bertambah. Terangkan mengapa.

*Based on the graph in (b)(i), as the number of carbon atoms increases so does the value of the heat of combustion. Explain why.*



menghasilkan lebih banyak molekul karbon dioksida dan air.

Oleh itu, semakin banyak haba dibebaskan.

*Produces more carbon dioxide and water molecules.*

*Therefore, more heat is released.*

..... [2M]

(iii) Hitungkan haba yang dibebaskan apabila 2.3 g etanol terbakar lengkap dalam udara. Diberi jisim atom relatif bagi C=12, H=1, O=16. Gunakan rumus:

Haba yang dibebaskan = Bilangan mol x Haba pembakaran

*Calculate the heat released when 2.3g of ethanol is completely burnt in air.*

*Given that the relative atomic mass of C=12, H=1, O=16.*

*Use the formula: Heat released = Number of moles X Heat of combustion. [2M]*

**Relative molecular mass of ethanol**

$$= (12 \times 2) + (1 \times 6) + 16 = 46$$

**Bilangan mol etanol**

$$\text{Number of moles ethanol} = \frac{2.3}{46} = 0.05 \text{ mol}$$

**Haba dibebaskan**

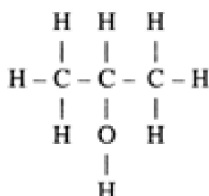
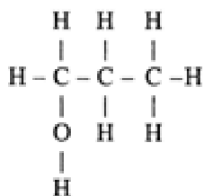
$$\begin{aligned} \text{Heat released} &= 0.05 \times 1376 \\ &= 68.8 \text{ kJ} \\ &= 68\,800 \text{ J} \end{aligned}$$

[2M]

(c) Metanol dan etanol tidak mempunyai isomer. Propanol mempunyai dua isomer. Lukiskan struktur dua isomer bagi propanol.

*Methanol and ethanol do not have isomers. Propanol has two isomers.*

*Draw the structures of the two isomers of propanol.*



[2M]

(d) Jadual 5.2 menunjukkan takat beku dan takat didih bagi merkuri, methanol, etanol dan butanol.

*Table 5.2 shows the freezing and the boiling points of mercury, methanol, ethanol and butanol.*

<b>Bahan</b> <i>Substance</i>	<b>Takat Beku/°C</b> <i>Freezing point /°C</i>	<b>Takat Didih /°C</b> <i>Boiling point /°C</i>
Merkuri <i>Mercury</i>	-39	357
Metanol <i>Methanol</i>	-97	64
Etanol <i>Ethanol</i>	-117	79
Butanol <i>Butanol</i>	-90	117

Suatu thermometer boleh mengandungi merkuri atau suatu alkohol. Termometer merkuri tidak sesuai digunakan untuk mengukur suhu di sekitar  $-100\text{ }^{\circ}\text{C}$ . Namakan alkohol yang sesuai digunakan dalam thermometer untuk mengukur suhu di sekitar  $-100\text{ }^{\circ}\text{C}$ . Berikan satu alasan sebab atas pilihan anda. [2M]

*A thermometer may contain mercury or an alcohol. A mercury thermometer is not suitable to measure the temperature at around  $-100\text{ }^{\circ}\text{C}$ . Name a suitable alcohol that can be used in a thermometer to measure the Temperature at around  $-100\text{ }^{\circ}\text{C}$ . Give **one** reason for your choice.*

Nama alkohol : .....

*Name of alcohol*

**Etanol/ Ethanol**

Sebab/ Reason : .....

**Etanol mempunyai takat beku,  $-117^{\circ}\text{C}$ , kurang daripada  $-100^{\circ}\text{C}$ // pada suhu  $-100^{\circ}\text{C}$ , etanol masih dalam keadaan cecair/ belum membeku**

*The freezing point of ethanol is  $-117\text{ }^{\circ}\text{C}$ , which is lower than  $-100\text{ }^{\circ}\text{C}$ ././ at  $-100^{\circ}\text{C}$ , ethanol is still liquid/ has not frozen*

**[SPM2018-08]** Table 2 shows the number of carbon atoms per molecule alcohol and the heat of combustion of methanol, ethanol, propanol and butanol.

Jadual 2 menunjukkan bilangan atom karbon per molekul alkohol dan haba pembakaran bagi metanol etanol, propanol dan butanol.

Alcohol Alkohol	Number of carbon atoms per molecule alcohol Bilangan atom karbon per molekul alkohol	Heat of combustion Haba pembakaran ( $\text{kJ mol}^{-1}$ )
Methanol Metanol	1	- 720
Ethanol Etanol	2	.....
Propanol Propanol	3	- 2030
Butanol Butanol	4	- 2680

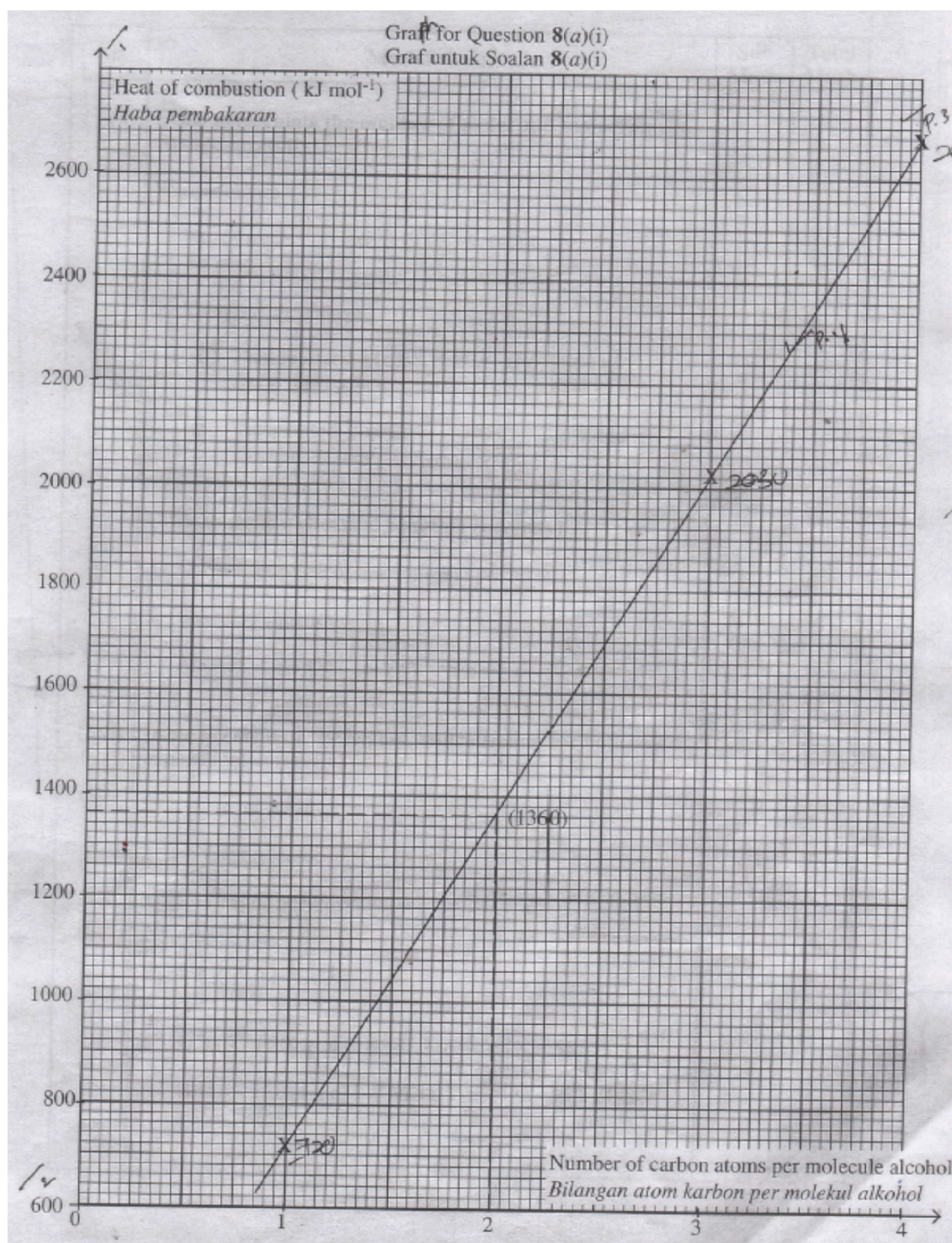
Table 2/ Jadual 2

(a) (i) By using the data in Table 2, plot a graph of heat of combustion against the number of carbon atoms per molecule alcohol on **page 21**.

From the graph plotted, determine the value of heat of combustion of ethanol.

Dengan menggunakan data pada Jadual 2, plot satu graf bagi haba pembakaran melawan bilangan atom karbon per molekul alkohol di **halaman 21**. Daripada graf yang diplot, tentukan nilai haba pembakaran bagi etanol.

[5M]



(ii) If 1.08 g of propanol is used to heat 200 cm<sup>3</sup> of water, calculate;  
Jika 1.08 g propanol digunakan untuk memanaskan 200 cm<sup>3</sup> air, hitung;

- the number of moles of propanol and the temperature change during the reaction.

[Given that molar mass of propanol = 60 g mol<sup>-1</sup>]

[Specific heat capacity of water,  $c = 4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$ ,

Density of water = 1.0 g cm<sup>-3</sup>]

bilangan mol propanol dan perubahan suhu semasa tindak balas.



[Diberi jisim molar propanol =  $60 \text{ g mol}^{-1}$ ][Muatan baba tertentu bagi air,  $c = 4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$ ,  
Ketumpatan air =  $1.0 \text{ g cm}^{-3}$ ]

- write a chemical equation for the complete combustion of butanol.  
tuliskan persamaan kimia bagi pembakaran lengkap butanol.

[5M]

$$\text{Bil mol propanol} = \text{jisim}/\text{JM} = 1.08/60 = \mathbf{0.018 \text{ mol}}$$

Gunakan  $\Delta H = \frac{\text{mol}}{H}$ ;  $H = mc\theta$

$$\Delta H = \frac{H}{\text{Mol}} \text{ maka } H = \text{mol} \times \Delta H = 0.018 \times 2030 = 36.54 \text{ kJ}$$

$H = mc\theta$ , tukarkan

$$\text{maka } \theta = \frac{H}{mc} = \frac{36540}{200 \times 4.2}$$

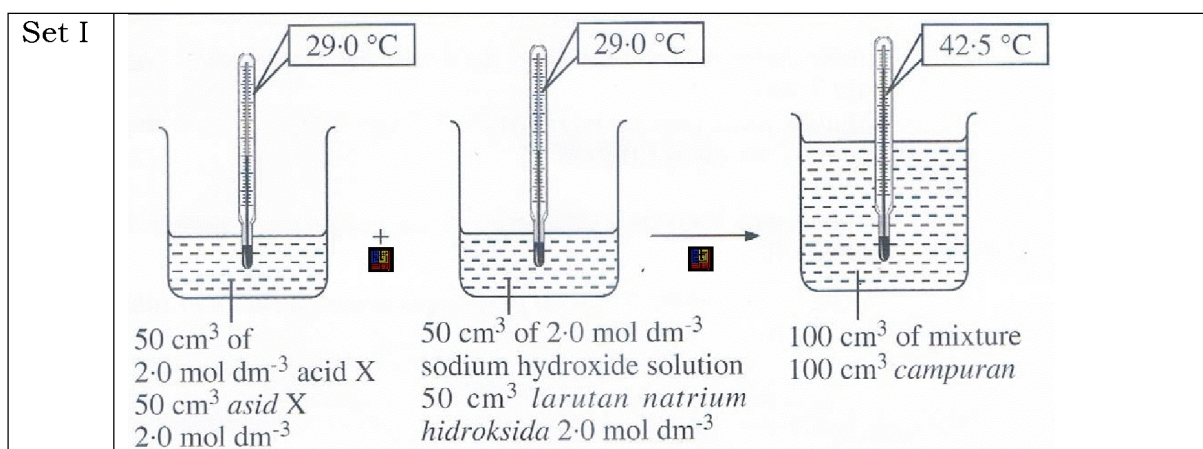
$$= \mathbf{43.5 \text{ }^\circ\text{C}}$$

Butanol



(b) Diagram 8 shows the apparatus set-up and the temperatures recorded to determine the heat of neutralisation using two types of acid, acid X and acid Y with sodium hydroxide solution.

Rajah 8 menunjukkan susunan radas dan suhu yang direkodkan untuk menentukan haha peneutralan menggunakan dua jenis asid, asid X dan asid Y dengan larutan natrium hidroksida.



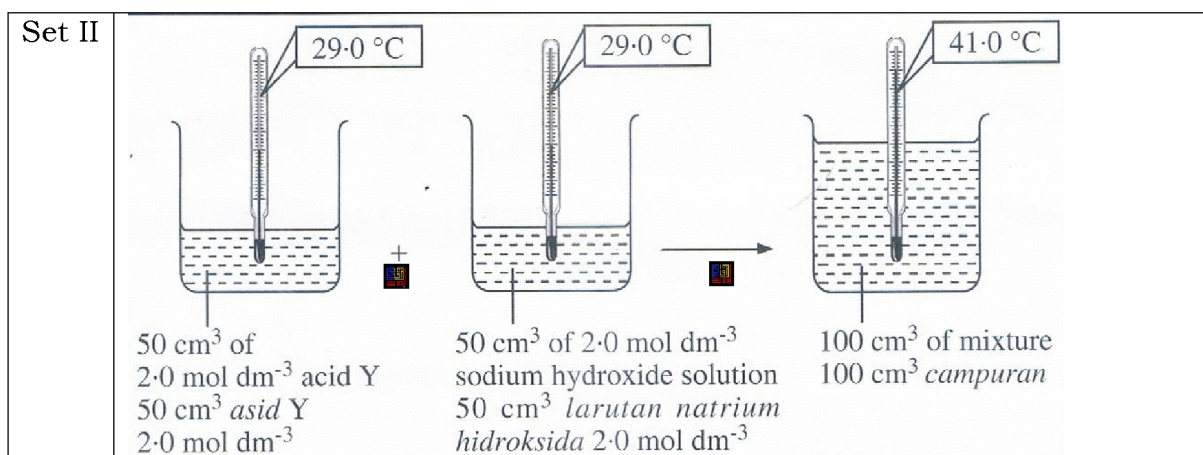


Diagram 8/ Rajah 8

Based on Diagram 8,/Berdasarkan Rajah 8,

(i) calculate the heat of neutralisation for Set I and Set II then suggest the types of acid X and acid Y.

[Specific heat capacity of water,  $c = 4.2 \text{ J g}^{-1} \text{ } ^\circ\text{C}^{-1}$ , Density of water =  $1.0 \text{ g cm}^{-3}$ ]  
hitung haba peneutralan bagi Set I dan Set II kemudian cadangkan jenis asid X dan asid Y.

[Muatan haba tertentu bagi air,  $c = 4.2 \text{ J g}^{-1} \text{ } ^\circ\text{C}^{-1}$ , Ketumpatan air =  $1.0 \text{ g cm}^{-3}$ ]

### Set I

$$\text{Mol asid X} = \frac{MV}{1000} = \frac{2.0 \times 50}{1000} = 0.1 \text{ mol}$$

$$H = mc\theta = 100 \times 4.2 \times 13.5 = 5670 \text{ J}$$

$$\Delta H = \frac{H}{\text{mol}} = \frac{5670}{0.1} = \underline{\underline{-56.7 \text{ kJ mol}^{-1}}}$$

### Set I

$$\text{Mol asid X} = \frac{MV}{1000} = \frac{2.0 \times 50}{1000} = 0.1 \text{ mol}$$

$$H = mc\theta = 100 \times 4.2 \times 12 = 5040 \text{ J}$$

$$\Delta H = \frac{H}{\text{mol}} = \frac{5040}{0.1} = \underline{\underline{-50.47 \text{ kJ mol}^{-1}}}$$

X : Strong acid/ Asid kuat

Y : Weak acid/ asid lemah

(ii) explain why there is a difference in the temperature change between Set I and Set II.

terangkan mengapa terdapat perbezaan dalam perubahan suhu antara Set I dan Set II.

Perubahan suhu pada set I adalah lebih tinggi

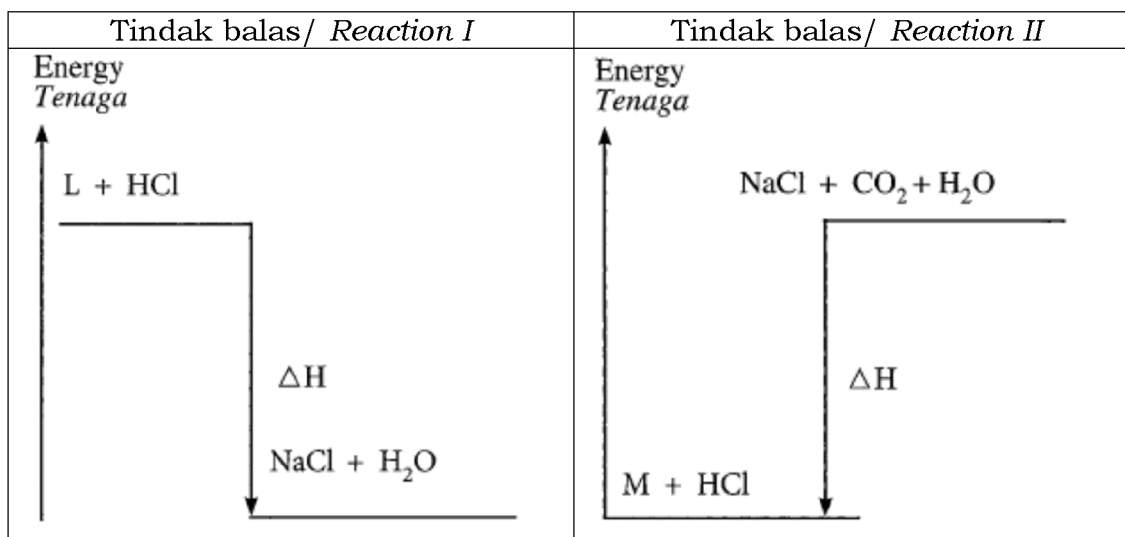
Temperature change in set I is higher

Asid X adalah asid kuat manakala asid Y ialah asid lemah  
 Acid X is a strong acid and acid Y is weak acid

Haba yang dibebaskan dalam set II diserap semula oleh asid Y untuk mengion molekul Y dengan lengkap  
 Heat released in Set II is absorbed by acid Y to ionise the molecules of acid Y completely

**[SPM2020-10]** Rajah 10 menunjukkan gambar rajah aras tenaga bagi dua tindak balas kimia berbeza menggunakan asid hidroklorik, HCl.

Diagram 10 shows the energy level diagram for two different chemical reactions using hydrochloric acid, HCl.



(a) Berdasarkan Rajah 10, cadangkan L dan M dan tentukan tanda bagi ΔH untuk kedua-dua tindak balas. Bandingkan dan deduksikan maklumat yang boleh diperolehi daripada gambar rajah aras tenaga bagi Tindak balas I dan Tindak balas II. [6 markah]

Based on Diagram 10, suggest L and M and determine the sign for ΔH for both reactions. Compare and deduce the information that can be obtained from the energy level diagrams for Reaction I and Reaction II. [6 marks]

L : Sodium hydroxide / NaOH// Natrium hidroksida

M : Sodium hydrogen carbonate / Sodium bicarbonate // NaHCO<sub>3</sub>//  
 Natrium hidrogen karbonat / Natrium bikarbonat

Reaction 1: ΔH negative and  
 Tindak balas I : ΔH negatif dan

Reaction II : ΔH positive//  
 dan Tindak balas II: ΔH positif



Reaction I Tindak balas I	Reaction II Tindak balas II
Exothermic / Releases heat energy // Eksotermik / Membebaskan tenaga haba	Edothermic // absorbs heat energy // Eksotermik / menyerap tenaga haba
Energy content of reactants is higher than product // Kandungan tenaga bagi bahan tindak balas lebih tinggi daripada basil tindak balas	Energy content of reactants is lower than product // Kandungan tenaga bagi bahan tindak balas lebih rendah daripada hasil tindak balas
Heat energy absorbed during the bonds is breaking lower than heat energy released during bonds formation // Tenaga haba diserap semasa pemutusan ikatan lebih rendah daripada tenaga haba dibebaskan semasa membentuk ikatan	Heat energy absorbed during bond breaking is higher than heat energy released during bonds formation // Tenaga haba diserap semasa pemutusan ikatan lebih tinggi daripada tenaga haba dibebaskan semasa pembentukan ikatan

(b) 2.85 kJ haba dibebaskan apabila asid sulfurik,  $\text{H}_2\text{SO}_4$  2.0 mol  $\text{dm}^{-3}$  bertindak balas dengan kalium hidroksida, KOH 2.0 mol  $\text{dm}^{-3}$ . Diberi haba peneutralan ialah  $-57 \text{ kJ mol}^{-1}$ .

*2.85 kJ of energy is released when 2.0 mol  $\text{dm}^{-3}$  of sulphuric acid,  $\text{H}_2\text{SO}_4$  reacts with 2.0 mol  $\text{dm}^{-3}$  of potassium hydroxide solution, KOH. Given that the heat of neutralisation is  $-57 \text{ kJ mol}^{-1}$ .*

Tulis persamaan kimia bagi tindak balas itu dan hitung isi padu asid sulfurik yang diperlukan. [4 markah]

*Write the chemical equation for the reaction and calculate the volume of sulphuric acid needed. [4 marks]*



$$\text{Number of moles of water} = \frac{2.85}{57} = 0.05$$

Bilangan mol air

$$\text{Volume of } \text{H}_2\text{SO}_4 = \frac{0.025 \times 1000}{2} = 12.5 \text{ cm}^3$$

Isi padu

(c) Jadual 3 menunjukkan jisim molekul relatif bagi alkohol W, X dan Y.  
*Table 3 shows the relative molecular mass for alcohols W, X and Y.*

Alkohol <i>Alcohol</i>	Bilangan atom karbon per molekul <i>Number of carbon atom per molecule</i>	Jisim molekul relatif <i>Relative molecular mass</i>
W	1	32
X	2	46
Y	3	60

Dengan memilih satu daripada alkohol dalam Jadual 3, nyatakan nama bagi alkohol tersebut dan huraikan satu eksperimen yang boleh dijalankan dalam makmal sekolah untuk menentukan haba pembakaran alkohol tersebut. Huraian anda mestilah mengandungi prosedur dan kaedah untuk menghitung haba pembakaran tersebut. [10 markah]

*By choosing one alcohol in Table 3, state the name of the alcohol and describe an experiment that can be carried out in the school laboratory to determine the heat of combustion for the alcohol.*

*Your description must include procedure and method to calculate the heat of combustion. [10 marks]*

1. W : Methanol // Metanol X : Ethanol // Etanol Y : Propanol

[Any one alcohol]

2. Pour [100 - 200] cm<sup>3</sup> of water into copper can  
Tuang [100 - 200] cm<sup>3</sup> air ke dalam bekas kuprum

3. Record the initial temperature of water  
Catat bacaan awal suhu air

4. Record the initial mass of spirit lamp with alcohol W  
Rekod jisim awal pelita dengan alkohol W

5. Place the lamp under the copper can and light the wick  
Letak pelita dibawah bekas kuprum dan nyalakan sumbu

6. When the temperature increasesd by 30 °C, stop heating and record the highest temperature of water  
Apabila suhu air meningkat sebanyak 30 °C, hentikan pemanasan dan rekod suhu tertinggi air

7. Record the mass of lamp after combustion  
Rekod jisim pelita selepas pembakaran

Calculation

Initial temperature // Suhu awal = T1 °C

Highest temperature I// Suhu tertinggi = T2 °C

Temperature change // Perubahan suhu = T2 – T1 =  $\theta$  °C

Mass of spirit lamp before combustion = p g  
Jisim pelita sebelum pembakaran

Mass of spirit lamp after combustion = q g  
Jisim pelita selepas pembakaran

Mass of alcohol burnt = p - q = r g  
Jisim alkohol yang terbakar

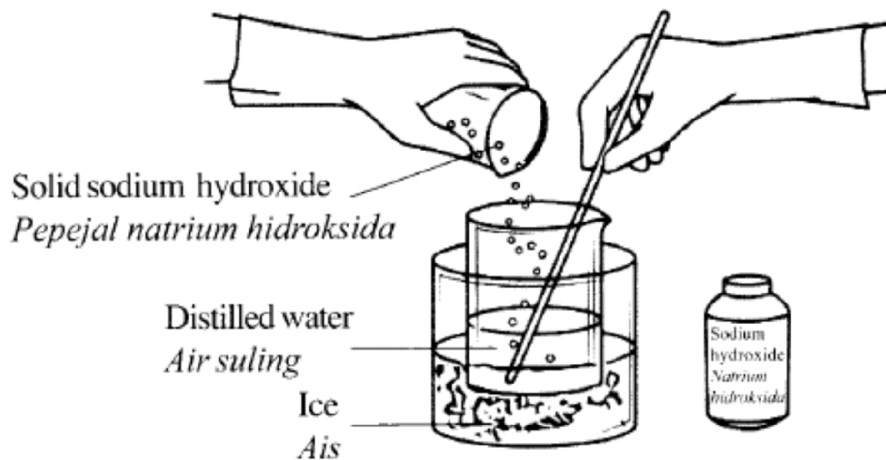
9. Heat lost = [200][4.2][ $\theta$ ] = 8400 J  
Haba yang hilang

$$\text{Number of mole alcohol } W = \frac{r}{32} = n$$

$$10. \Delta H = \frac{-8400 \text{ J mol}^{-1}}{n}$$

**[SPM2016-10]** (a) Rajah 10.1 menunjukkan bagaimana larutan stok natrium hidroksida disediakan oleh pembantu makmal.

Diagram 10.1 shows how stock solution of sodium hydroxide is prepared by a lab assistant.



Terangkan mengapa pembantu makmal menggunakan ais untuk membantunya menyediakan larutan natrium hidroksida. Apabila 1 mol pepejal natrium hidroksida larut dalam air, ia menghasilkan 44.51 kJ haba. Hitung perubahan suhu jika 0.5 mol pepejal natrium hidroksida dilarutkan dalam 800 cm<sup>3</sup> air suling. [4 markah]

Explain why the lab assistant uses ice to aid her preparation of sodium hydroxide solution. When 1 mol of solid sodium hydroxide is dissolved in water, it produces 44.51 kJ of heat. Calculate the temperature change if 0.5 mol of solid sodium hydroxide is dissolved in 800 cm<sup>3</sup> of distilled water. [4 marks]

1. Tindak balas adalah terlalu eksotermik/ menghasilkan tenaga haba yang sangat banyak

The reaction very exothermic/ releases a lot of heat

2. ais menyerap haba yang terbebas

Ice absorbs the heat released

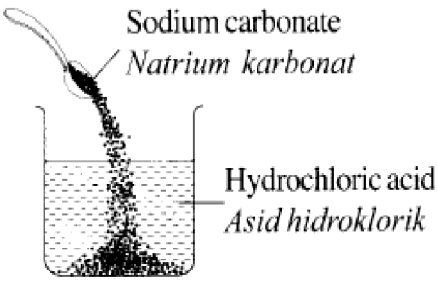
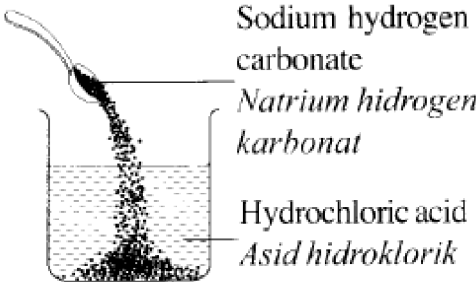
Pengiraan/ Calculation

$$Q = 44.51 \times 0.5 \times 1000 \text{ J} = 22\,255 \text{ J}$$

$$\theta = 22\,255 / (800 \times 4.2) = 6.62 \text{ }^\circ\text{C}$$

10 (b) Jadual 10 menunjukkan haba tindak balas bagi tindak balas antara asid hidroklorik, HCl dengan natrium karbonat, Na<sub>2</sub>CO<sub>3</sub> dan natrium hidrogen karbonat, NaHCO<sub>3</sub>.

Table 10 shows the heat of reaction for the reaction between hydrochloric acid, HCl with sodium carbonate, Na<sub>2</sub>CO<sub>3</sub> and sodium hydrogen carbonate, NaHCO<sub>3</sub>

Tindak balas Reaction	I	II
Bahan tindak balas Reactant		
Haba tindak balas Heat of reaction	-X kJ mol <sup>-1</sup>	- Y kJ mol <sup>-1</sup>

Berdasarkan Jadual 10, banding Tindak balas I dengan Tindak balas II dari segi:

- Jenis tindak balas
- Perubahan suhu
- Perubahan jumlah kandungan tenaga bahan tindak balas dan jumlah kandungan tenaga hasil tindak balas
- Pembentukan dan pemecahan ikatan

Berikan satu contoh lain bagi Tindak balas I dan Tindak balas II. [6 markah]

Based on Table 10, compare Reaction I and Reaction II in terms of:

- Type of reaction
- Temperature change
- Change in the total energy content of reactants and the total energy content of products
- Formation and breaking of bond

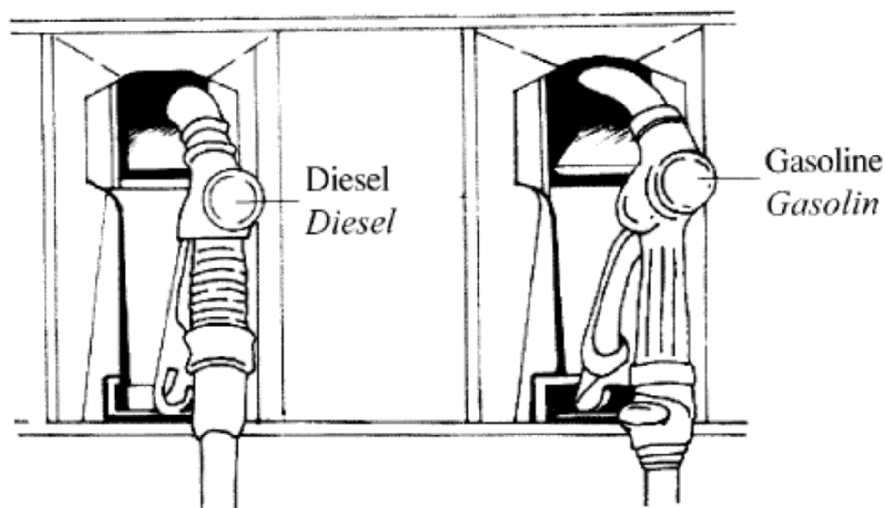
Give another example for Reaction I and Reaction II. [6 marks]

Tindak balas Reaction	I	II
Jenis tindak balas Type of reaction	Eksotermik exothermic	Endotermik endothermic
Perubahan suhu Temperature change	Suhu menaik/ bertambah Temperature rises/ increases	Suhu menurun/ berkurangan Temperature drops/ decreases
Perubahan jumlah kandungan tenaga Change in total energy content	Jumlah kandungan tenaga bahan tindak balas <b>lebih</b> daripada kandungan tenaga hasil tindak balas	Jumlah kandungan tenaga bahan tindak balas <b>kurang</b> daripada kandungan tenaga hasil tindak balas

	<i>Total energy content of reactant is <b>greater</b> than total energy content of product</i>	<i>Total energy content of reactant is <b>less</b> than total energy content of product</i>
<i>Pembentukan ikatan dan pemecahan ikatan Bond formation and bond breaking</i>	<i>Haba yang bebaskan semasa pembentukan ikatan adalah lebih besar daripada haba yang diserap semasa pemecahan ikatan Heat released during bond formation is greater than heat absorbed during bond breaking</i>	<i>Haba yang bebaskan semasa pembentukan ikatan adalah lebih <b>kecil</b> daripada haba yang diserap semasa pemecahan ikatan Heat released during bond formation is <b>smaller</b> than heat absorbed during bond breaking</i>

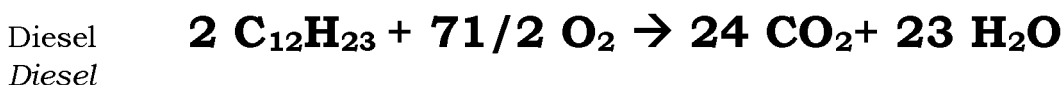
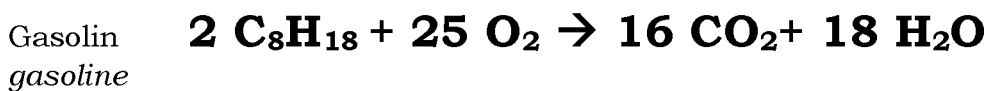
10 (c) Rajah 10.2 menunjukkan dua bahan api berlainan yang boleh diperolehi dengan mudah di stesen petrol.

Diagram 10.2 shows two different fuels that can be easily obtained in petrol station.



Persamaan kimia berikut menunjukkan pembakaran lengkap gasolin,  $C_8H_{18}$  dan diesel,  $C_{12}H_{23}$ .

The following chemical equation shows the complete combustion of gasoline,  $C_8H_{18}$  and diesel,  $C_{12}H_{23}$ .



Haba pembakaran bagi diesel adalah lebih besar daripada gasolin disebabkan bilangan atom karbon per molekul di dalam diesel lebih tinggi.

Huraikan satu eksperimen untuk membandingkan haba pembakaran antara gasolin dengan diesel. Huraian anda haruslah mengandungi prosedur dan langkah pengiraan. [Jisim atom relatif: H = 1; C = 12]

[Muatan haba tentu larutan =  $4.2 \text{ Jg}^{-1}\text{C}^{-1}$ ] [10 markah]

*The heat of combustion for diesel is greater than gasoline due to the higher number of carbon atom per molecule in diesel. Describe an experiment to compare the combustion heat between gasoline and diesel. Your description should include procedure and steps of calculation. [Relative atomic mass: H = 1; C = 12]*

[Specific heat capacity of solution =  $4.2 \text{ Jg}^{-1}\text{C}^{-1}$ ] [10 marks]

**Prosedur/ procedure**

1. sukut [50 – 250] cm<sup>3</sup> air dan tuangkan ke dalam tin kuprum// tin aluminium  
*Measure [50 – 250] cm<sup>3</sup> of water and pour it into copper can// aluminium can*

2. rekod/ sukut suhu awal air  
*Record/ measure the initial temperature of water*

3. timbang dan rekod jisim awal pelita dan gasolin  
*Weigh and record the initial mass of lamp and gasoline*

4. letakkan pelita di bawah tin kuprum dan nyalakan sumbu  
*Place the lamp under the copper can and light the wick// heat the water*

5. kacau air itu  
*Stir the water*

6. apabila suhu meningkat kira-kira 30°C. Padamkan nyalaan dan rekod bacaan suhu tertinggi air  
*When temperature rises about 30°C, put out the flame and record the highest temperature of water.*

7. Timbang pelita secepat mungkin dan rekod jisim akhir  
*Weigh the lamp as quickly as possible and record the final mass*

8. Ulang langkah 1 hingga 7 dengan diesel  
*Repeat step 1 to 7 with diesel*

**Keputusan/ result**

	Gasolin Gasoline	Diesel diesel
Suhu permulaan bagi air (°C) = <i>Initial temperature of water</i>	T <sub>1</sub>	T <sub>3</sub>
Suhu tertinggi bagi air (°C) = T <sub>2</sub> <i>Highest temperature of water</i>	T <sub>2</sub>	T <sub>4</sub>
Jisim pelita + gasolin sebelum pemanasan (g) = M <sub>1</sub> <i>Mass of lamp + gasoline before heating (g)</i>	M <sub>1</sub>	M <sub>3</sub>
Jisim pelita + gasolin selepas pemanasan (g) = M <sub>2</sub> <i>Mass of lamp + gasoline after heating (g)</i>	M <sub>2</sub>	M <sub>4</sub>



*Pengiraan / calculation*

**Kena tunjukkan 2 pengiraan – petrol dan diesel**

Bilangan mol =  $M1 - M2 / \text{jisim molar}$

Number of moles =  $M1 - M2 / \text{molar mass}$

Haba yang dibebaskan/ heat released

$$Q = 100 \times 4.2 \times [T2 - T1]$$

Haba pembakaran/ heat of combustion

$$\Delta H = Q / \text{mol [tunjukkan pengiraan sbb dalam soalan suruh]}$$

Kesimpulan/ conclusion


Haba pembakaran diesel lebih besar daripada gasolin

*Heat of combustion of diesel is greater than gasoline*

**Bab 12**

**[Selangor2022-Set01-05]** Rajah 5.1 menunjukkan satu produk yang dihasilkan daripada polimer X dan formula strukturnya.

Diagram 5.1 shows a product made of polymer X and its structural formula.

	$\left[ \begin{array}{cc} \text{H} & \text{Cl} \\   &   \\ -\text{C} & -\text{C}- \\   &   \\ \text{H} & \text{H} \end{array} \right]_n$
Polimer/ polymer X	

(a) Apakah maksud polimer? / What is the meaning of polymer?

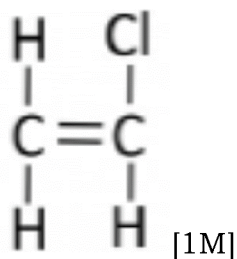
*Molekul berantai panjang yang terbentuk daripada gabungan banyak unit kecil yang sama dipanggil monomer.*

*Long chain molecules formed from a combination of many of the same small units are called monomers.*

..... [1M]

(b) Lukis formula struktur bagi monomer yang membentuk polimer X.

Draw the structural formula of the monomer that forms polymer X.



(c) Nyatakan satu cara polimer X menyebabkan pencemaran alam sekitar.

State one way polymer X causes environmental pollution.

*Pembakaran PVC akan membebaskan gas yang menyebabkan hujan asid.*

*Combustion of PVC will release gases that cause acid rain.*

..... [1M]

(d) Rajah 5.2 menunjukkan lateks didedahkan dalam udara untuk suatu jangka masa yang lama.

Diagram 5.2 shows latex is exposed in air for a long period of time.



(i) Apakah yang akan berlaku pada lateks? Terangkan jawapan anda.  
What will happen to latex? Explain your answer.

- Lateks menggumpal
- Bakteria dari udara masuk ke dalam lateks, aktiviti bakteria dalam lateks menghasilkan asid laktik yang mengandungi ion hidrogen
- Ion hidrogen bercas positif daripada asid meneutralkan cas-cas negatif pada permukaan membran protein
- Zarah-zarah neutral berlanggar antara satu sama lain menyebabkan membran pecah dan molekul getah bergabung antara satu sama lain
- *Latex coagulate*
- *Bacteria from the air enter the latex, the activity of bacteria in the latex produces lactic acid which contains hydrogen ions*
- *Positively charged hydrogen ions from acids neutralize negative charges on the surface of protein membranes*
- *Neutral particles collide with each other causing the membrane to break and the rubber molecules combine each other*

..... [4M]

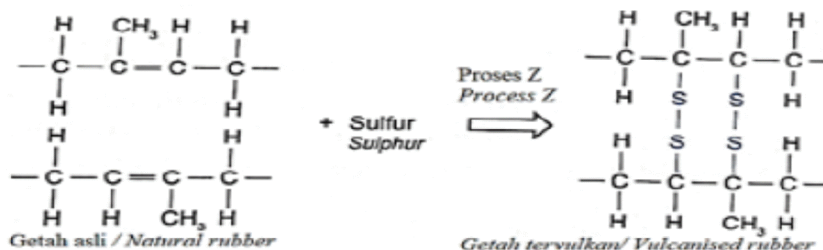
(ii) Namakan bahan kimia yang digunakan untuk mencegah proses di 5(d)(i).  
Name the chemical used to prevent the process in 5(d)(i).

Larutan ammonia/ Ammonia solution

..... [1M]

**[Perak2022-Set01-07]** (a) Rajah 7 menunjukkan bagaimana Proses Z menukarkan getah asli ke getah tervulkan

Diagram 7 shows how Process Z convert natural rubber into vulcanised rubber



Berdasarkan Rajah 7/ Based on Diagram 7

(i) Apakah nama proses Z? ..... [1M]  
What is the name of process Z?

Pemvulkanan/ Vulcanisation

(ii) Terangkan bagaimana getah tervulkan dihasilkan.

Explain how vulcanised rubber is produced.

*Celup kepingan getah asli ke dalam larutan disulfur diklorida. S<sub>2</sub>Cl<sub>2</sub>*

*Dip natural rubber into disulphur dichloride, S<sub>2</sub>Cl<sub>2</sub> solution*

..... [1M]

(iii) Getah yang manakah lebih elastik? Terangkan jawapan anda

Which rubber is more elastic? Explain your answer.

*P1: Getah tervulkan*

*P2: Rangkaian silang sulfur yang kuat terbentuk*

*P3: Ia dapat menghalang rantai-rantai polimer getah daripada mengelongsor apabila diregangkan dan dapat kembali kepada bentuk asal*

*P1: Vulcanised rubber*

*P2: Strong cross-link formed*

*P3: it can prevent the rubber polymer chains from sliding past freely each other when they are stretched and can return to their original shape*

..... [3M]

(b) Penggunaan getah sintetik yang tidak terkawal membawa kepada masalah pencemaran alam

Uncontrolled usage of synthetic rubber leads to environmental pollution problems.

(i) Cadangkan 2 cara untuk mengatasi masalah akibat penggunaan getah sintetik yang berleluasa.

Suggest 2 ways to overcome the problems resulting from the widespread usage of synthetic rubber.

*P1: Pelupusan getah sitetik yang sistematik dapat mengurangkan masalah pencemaran alam.*

*Systematic disposal of synthetic rubber is essential to reduce environmental pollution.*

*P2: menguatkuasakan undang-undang yang lebih ketat terhadap kilang dan mengitar semula barangan getah sintetik*

*Enforce stricter laws against factories and recycling synthetic rubber products.*

..... [2M]

(ii) Apakah 3 kelebihan sarung tangan yang di buat daripada getah sintetik berbanding dengan getah asli?

What are 3 advantages of gloves made form synthetic rubber as compared to natural rubber?

*P1: tahan minyak atau gris*

*Oil and grease resistant*

*P2: tahan lasak*

*More durable*

*P3:tahan haba*

*Heat resistant*

..... [3M]

**[Putrajaya2022-06]** Getah asli ialah polimer semula jadi.

Natural rubber is a natural polymer.

(a) Nyatakan dua contoh polimer semula jadi selain daripada getah asli.

State two examples of natural polymer besides natural rubber.

- Protein / Protein

- Kanji / Starch

[Mana – mana jawapan yang dirasakan sesuai / Any other suitable answers]

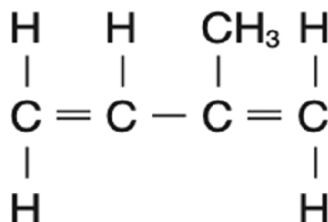
..... [2M]

(b) Lukiskan formula struktur dan tuliskan nama IUPAC bagi monomer getah asli.

Draw the structural formula and write IUPAC name for the monomer of natural rubber.

• Lukisan / Drawing

• 2-metilbut-1,3-diena // 2-methylbut-1,3-diene



[2M]

(c) Tayar kapal terbang diperbuat daripada getah tervulkan.

The tyres of aircrafts are made from vulcanised rubber.

(i) Apakah pemvulkanan getah?/What is vulcanisation of rubber?

Pemvulkanan adalah proses di mana atom sulfur getah membentuk rangkaian silang antara rantai polimer getah bersebelahan pada ikatan berganda antara atom karbon //

*Vulcanisation is a process whereby sulphur atoms form cross-link between adjacent chains of rubber polymer at the double bond between carbon atoms.*

..... [1M]

(ii) Terangkan mengapa getah tervulkan adalah lebih kenyal daripada getah tak tervulkan.

Explain why vulcanised rubber is more elastic than unvulcanised rubber.

- Atom – atom sulfur membentuk rangkai silang di antara molekul panjang getah./

The sulphur atoms form cross-link between the long rubber molecule.

- Ini mengurangkan kebolehan polimer untuk menggelongsor antara satu sama lain.

This reduces the ability of the polymers to slide over each other.

- Molekul – molekul getah Kembali kepada kedudukan asal selepas diregangkan.  
The rubber molecules return to their original positions after being stretched.

..... [3M]

(iii) Tuliskan satu kaedah alternatif pemvulkanan getah tanpa penggunaan sulfur.

Write one alternative method of vulcanisation of rubber without the use of sulphur.

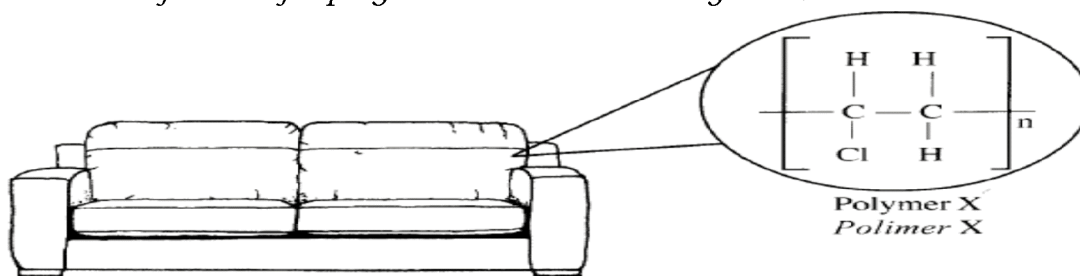
- Menggunakan logam oksida // Using metal oxides
- Menggunakan peroksida // Using peroxide
- Penyinaran // Irradiation

[Mana – mana jawapan yang dirasakan sesuai / Any other suitable answers]

..... [1M]

**[SPM2016-02]** (a) Sofa dibalut dengan bahan yang mengandungi polimer X yang terdiri daripada unit asas. Formula struktur bagi polimer X ditunjukkan dalam Rajah 2.1.

Sofa is covered by a material that contains polymer X which consist of basic units. The structural formula for polymer X is shown in Diagram 2.1.



(i) Apakah yang dimaksudkan dengan polimer?

What is the meaning of polymer?

**Molekul** besar yang dibina oleh [ulangan banyak] unit asas/monomer

A large **molecule** that is made up of many identical repeating sub-units/ monomers

.....[1M]

(ii) Nyatakan nama bagi unit asas yang membentuk polimer X.

State the name of the basic unit that forms polymer X.

**Kloroetena/ vinil klorida**

**Chloroethene/ vinyl chloride**

.....[1M]

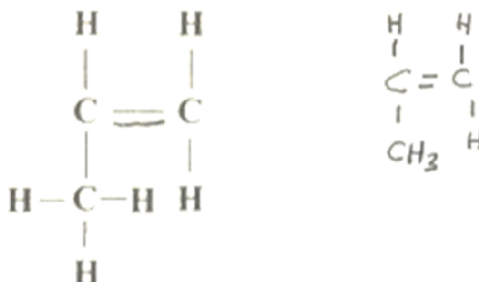
(b) Klorin, Cl dalam polimer X seperti yang ditunjukkan dalam Rajah 2.1

digantikan dengan metil, CH<sub>3</sub> untuk membentuk polimer Y.

Chlorine, Cl in polymer X as shown in Diagram 2.1 is replaced with methyl, CH<sub>3</sub> to form polymer Y.

(i) Lukis formula struktur bagi unit asas polimer Y.

Draw the structural formula for the basic unit of polymer Y.





(ii) Nyatakan nama bagi polimer Y. ....[1M]

*State the name of polymer Y.*

Poliprepena/ / polypropene

(iii) Nyatakan satu persamaan dan satu perbezaan antara formula struktur bagi polimer Y dan unit asasnya di 2(b)(i).

*State one similarity and one difference between the structural formulae of polymer Y and its basic unit in 2(b)(i).*

polimer Polymer	Unit asa dalam 2(b)(i) Basic unit in 2(b)(i)
Mengandungi C dan H Contain of C and H	Mengandungi C dan H Contain of C and H
Formula empirik, CH <sub>2</sub> Empirical formula	Formula empirik, CH <sub>2</sub> Empirical formula
Formula molekul, (C <sub>3</sub> H <sub>6</sub> ) <sub>n</sub> Molecular formula	Formula molekul, C <sub>3</sub> H <sub>6</sub> Molecular formula
Mengandungi ikatan tunggal antara atom karbon Contain single bond between carbon atom	Mengandungi ikatan ganda dua antara atom karbon Contain double bond between carbon atom

.....[2M]

(c)



Salah satu penggunaan polimer adalah membuat botol plastik. Pelupusan botol plastik yang tidak terurus boleh menyebabkan pencemaran. Berdasarkan Rajah 2.2 dan isu pencemaran, yang dihadapi oleh negara kita, wajarkan penggunaan polimer.

*One of the uses of polymer is to make plastic bottle. Improper disposal of plastic bottles can cause pollution. Based on Diagram 2.2 and the pollution issue, faced by our nation, justify the use of polymer.*

1a sesuai digunakan/ suitable to be used/ make our life easier

2a cheaper/ lebih murah// menjimatkan kos

Lebih Ringan/ lighter// less dense than water // (any suitable reason)

3a Reuse// guna semua// boleh di buat bot

Can be inovated various useful item// boleh dibuat inovasi kepada pelbagai bahan berguna

2. 1b not suitable to be used// should be reduced// tidak sesuai digunakan

2b improper dispose off// pelupusan yang tidak betul// non-biodegradable/  
cannot decompose

3b can cause pollution// boleh menyebabkan pencemaran

Eq poisonous gas/ floating

.....[3M]

**[SPM2016-07a]** (a) Ahmad adalah seorang penoreh getah. Setiap hari dia mengutip lateks tersebut yang bertukar menjadi pepejal. Terangkan bagaimana lateks bertukar kepada bentuk pepejal. [4 markah]

*Ahmad is a rubber tapper. Everyday he collects the latex that turn into solid.*

*Explain how the latex changes to solid form. [4 marks]*

1. Bakteria menghasilkan asid/ *Bacteria produce acid*

2. asid/ ion  $H^+$  meneutralkan cas negatif pada membran protein

*Acid/ $H^+$  ion neutralize negative charges of protein membrane (mesti ada)*

3. zarah-zarah getah berlanggar antara satu sama lain menyebabkan membran protein pecah

*Rubber particles collide with one another cause the breakage of the protein membranes*

4. molekul-molekul getah bergabung bersama

*The rubber molecules entangle/ombine together*

**Bab 13**

**[Selangor2022-Set02-06] [Selangor2022-Set3-06]**

Rajah 6 menunjukkan pelbagai kosmetik di pasaran.

Diagram 6 shows various types of cosmetics found in the market.



(a) (i) Nyatakan maksud kosmetik. / State the meaning of cosmetics.

*Kosmetik ialah bahan atau produk yang digunakan secara luaran untuk membersihkan, melindungi atau mencantikkan penampilan seseorang.*

*Cosmetics are materials or products that are used externally to cleanse, protect or enhance one's appearances.*

..... [1M]

(ii) Nyatakan dua bahan asas dalam pembuatan kosmetik.

State two basic ingredients in cosmetics production.

*Pewarna / air / pengawet / pelembab / pewangi / pengemulsi / pemekat (pilih mana-mana dua)*

*Dyes / water / preservatives / moisturisers / fragrances / emulsifiers / thickeners (choose any two)*

..... [2M]

(b) Terdapat kosmetik yang dikomersialkan mengandungi bahan kimia terlarang yang boleh mengakibatkan kemudaratan kepada pengguna.

Some of the commercialized cosmetics contain banned chemicals that can cause harm to consumers.

(i) Nyatakan dua kesan penggunaan bahan kimia terlarang kepada pengguna.

State two effects of the use of banned chemicals substance to consumers.

*Kulit merengsa / kerosakan ginjal / pengurangan pigmentasi mengakibatkan pendedahan kulit kepada sinaran UV / kulit menjadi hipersensitif (pilih mana-mana dua)*

*(pilih mana-mana dua)*

*Skin irritation / kidney damage / reduction of pigmentation results in skin exposure to UV rays / skin becomes hypersensitive*

*(choose any two)*

..... [2M]

(ii) Cadangkan satu cara untuk mencegah keadaan di 6(b)(i) berlaku.

Suggest one method to prevent the situation in 6(b)(i) from happening.

Guna kosmetik buatan sendiri yang mengandungi bahan semula jadi / baca label dan faham kandungan sesuatu kosmetik sebelum menggunakannya  
*Use homemade cosmetics that contain natural ingredients / read the label and understand the content of a cosmetic before using it*

..... [1M]

(c) Jadual 6 menunjukkan tiga jenis sebatian kimia yang digunakan sebagai bahan tambah makanan.

Table 6 shows three types of chemical compounds which are used as food additives.

Jenis bahan tambah makanan Types of food additives	Sebatian kimia Chemical compounds	Produk Products
X	Asid benzoik Benzoic acid	Sos cili Chilli sauces
Y	Mononatrium glutamat Monosodium glutamate	Mi segera Instant noodles
Z	Asid askorbik Ascorbic acid	Marjerin Margarine

(i) Terangkan bagaimana asid benzoik bertindak sebagai bahan tambah makanan X.

Explain how benzoic acid acts as food additive X.

*Asid benzoik menghalang sos cili daripada rosak dengan memperlahankan pertumbuhan mikroorganisma.*

*Benzoic acid prevents chilli sauces from being spoilt by slowing down the growth of microorganism.*

..... [1M]

(ii) Apakah kesan sampingan mononatrium glutamat ke atas kesihatan manusia?  
 What is the side effect of monosodium glutamate on human health?

*Keguguran rambut / pening kepala*

*Falling hair / headache*

..... [1M]

(iii) Apakah fungsi bahan tambah makanan Z?

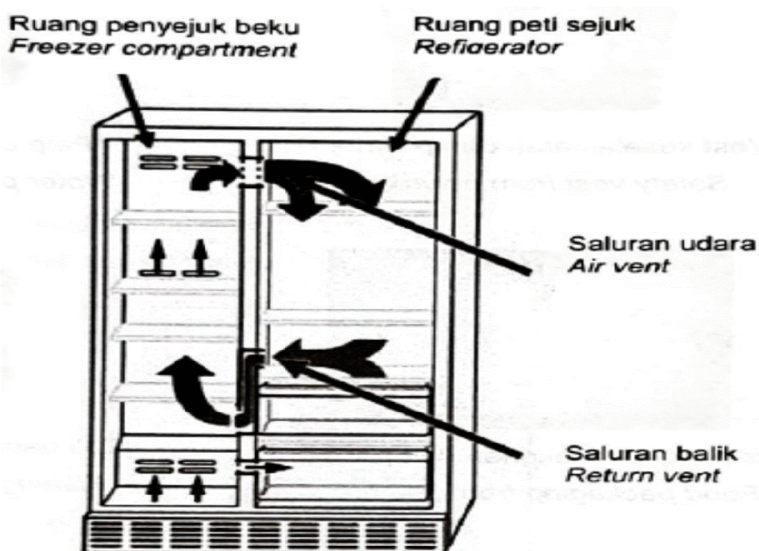
What is the function of food additive Z?

*Melambatkan pengoksidaan lemak dalam makanan.*

*Slow down the oxidation of fats in food.*

..... [1M]

**[Kedah2022-04]** Rajah 4.1 menunjukkan sebuah peti ais yang dilapisi teknologi antibakteria nano titanium dalam bahagian sistem pembersihannya. Diagram 4.1 shows a refrigerator coated with titanium nano antibacterial technology in its cleaning system.



(a) (i) Apakah yang dimaksudkan dengan nanoteknologi?  
What is the meaning of nanotechnology?

**Nanoteknologi ialah pembangunan bahan atau peranti dengan memanfaatkan ciri-ciri zarah nano**  
**Nanotechnology is the construction of materials or devices by utilizing the characteristics of nano particles**

..... [1M]

(ii) Nyatakan satu kelebihan penggunaan nanoteknologi ke atas makanan yang disimpan di dalam peti ais dalam Rajah 4.1.  
State one advantage of the use of nanotechnology over food stored in the refrigerator in Diagram 4.1.

**Membunuh mikroorganisma// membasmi kuman//makanan dapat bertahan lebih lama**  
**Killing microorganisms// food lasts longer/fresher**

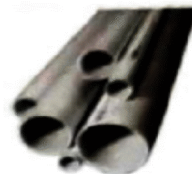
..... [1M]

(b) Rajah 4.2 di bawah menunjukkan pelbagai barangan yang terdiri daripada polimer.  
Diagram 4.2 below shows a variety of items composed of polymers

Diagram 4.2 below shows a variety of items composed of polymers



Vest keselamatan dan polimer P  
Safety vest from polymer P



Paip air dari polimer Q  
Water pipes of polymer Q



Pembungkus makanan dan polimer R  
Food packaging from polymer R

tali Pancing dari polimer S  
Fishing line of polymer S

Rajah 4.2/ Diagram 4. 2

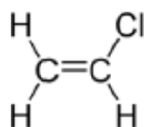
(i) Kelaskan bahan P, Q, R dan S mengikut tindak balas pempolimeran.  
Classify materials P, Q, R and S according to the polymerization reaction. [2M]

Pempolimeran penambahan Addition polymerization	Pempolimeran kondensasi Condensation polymerization
Q R	P S

(ii) Namakan polimer bagi R. .... [1M]  
Name the polymer for R.

Polistirena / polystyrene

(iii) Lukis formula struktur monomer bagi polimer Q.  
Draw the monomer structure formula for polymer Q.



[2M]