4541/2 (PP)
Chemistry
Kertas 2
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MAKTAB RENDAH SAINS MARA
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PEPERIKSAAN AKHIR SIJIL PENDIDIKAN MRSM 2020

CHEMISTRY

Kertas 2

Peraturan Pemarkahan

Untuk Kegunaan Pemeriksa Sahaja

Peraturan Pemarkahan ini mengandungi 19 halaman bercetak
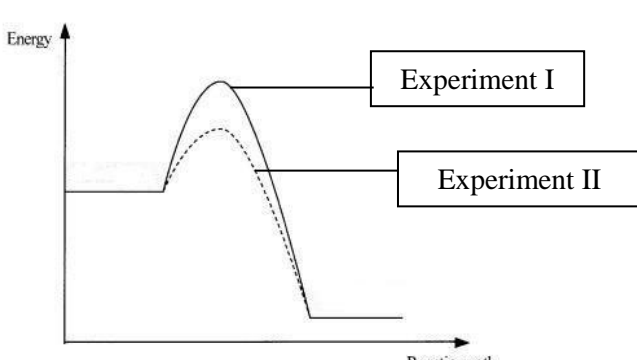
MARKING GUIDELINES
SPMRSM
CHEMISTRY PAPER 2

Symbol		Meaning
//	-	replace the whole sentence
/	-	replace the previous word
[ ]	-	can be summarized from explanation
___ or bold	-	key word
adp	-	avoid double penalty
wcr	-	wrong cancel right
a.	-	accept
r.	-	reject
ecf	-	error carry forward

1		**MARK SCHEME**	**SUB MARK**	**TOTAL MARK**
(a)	(i)	**[Able to state definition for melting point correctly]** Answer Temperature at which solid change to liquid [at particular pressure]	1	1
	(ii)	**[Able to state the physical properties of substance R at room temperature]** Answer : Gas	1	1
	(iii)	**[Able to state the change of kinetic energy and attraction forces between particles of substances Q]** Sample answer P1. Kinetic energy decreases P2. Attraction force between particles / molecules becomes stronger	1 1	2
(b)	(i)	**[Able to state a labeled beaker that shows the reaction of potassium with water]** Answer: X	1	1
	(ii)	**[Able to name gas produced correctly]** Answer: Hydrogen	1	1
	(iii)	**[Able to write a balanced chemical equation correctly]** Answer: $$2Li + 2H_2O \rightarrow 2LiOH + H_2 \;//$$ $$2Na + 2H_2O \rightarrow 2NaOH + H_2$$ P1.Correct formula of reactants & products P2.Balance	1 1	2
	(v)	**[Able to infer the density of metal group 1 in water]** Sample answer: Group 1 metals have lower density than water // Group 1 metals are less dense than water	1	1
			Total	**9**

2		MARK SCHEME	SUB MARK	TOTAL MARK
(a)		**[Able to state all ion present in copper(II) sulphate correctly]** Answer: Cation: Cu^{2+}, H^+ Anion: SO_4^{2-}, OH^- *[a: Name]*	1 1	2
(b)		**[Able to state the negative terminal correctly]** Answer: Zinc *[a: Formula]*	1	1
(c)	(i)	**[Able to state the observation at zinc metal]** <u>Sample answer</u> Zinc metal thinner/ smaller /dissolve	1	1
	(ii)	**[Able to write half equation at zinc electrode and copper electrode correctly]** Answer: Zinc electrode: $Zn \rightarrow Zn^{2+} + 2e$ Copper electrode: $Cu^{2+} + 2e \rightarrow Cu$	1 1	2
	(iii)	**[Able to state the observation of copper(II) sulphate solution and reason]** <u>Sample answer</u> P1. <u>Blue solution</u> becomes pale blue / paler // Intensity of blue solution decreases *[r: <u>Blue solution</u> becomes colourless]* P2. Concentration of Cu^{2+} / copper(II) ion decreases.	1 1	2
(d)	(i)	**[Able to suggest a suitable metal to replace zinc]** Answer: Mg // Al *[reject: Metal Group 1, Ca]*		1
			Total	9

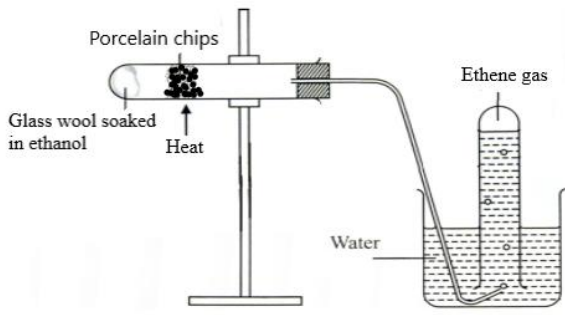| 3		MARK SCHEME	SUB MARK	TOTAL MARK
(a)		**[Able to name solution T]** Answer: Zinc chloride *[a: formula]*	1	1
(b)		**[Able to explain to identify and confirmed gas U]** <u>Sample answer</u> P1. Placed a burning wooden splinter at the mouth / into the test tube. P2. 'Pop' sound produced indicates H_2 gas	1 1	2
(c)	(i)	**[Able to write and balance chemical equation of zinc and hydrochloric acid]** Answer: $$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$ P1. Correct formulae of reactants and products P2. Balance equation	1 1	2

	(ii)	**[Able to calculate the maximum volume of gas U at room temperature]**
		
		<u>Sample answer</u>
		P1. No. of mol HCl = $\dfrac{1.0 \times 20}{1000}$ = 0.002
		
		P2. 2 mol HCl : 1 mol H_2
		     0.002 mol HCl : 0.001 mol H_2
		     [a : sentence relationship]
		
		P3. Volume of H_2 = 0.001x 24
		          = 0.024 dm^3 // 24 cm^3
			1
			
			1
			
			1
				3

(d)		**[Able to explain to separate substance V from the mixture]** <u>Sample answer</u> P1. Filter the mixture [reject: filtration] P2. Rinse with distilled water	1 1	2
			Total	**10**

4		MARK SCHEME	SUB MARK	TOTAL MARK
(a)		**[Able to state the condition for rusting correctly]**		
		Answer: oxygen and water *[a: formula]*	1	1
(b)	(i)	**[Able to state the substance that is oxidised correctly]**		
		Answer: Iron *[r: formula]*	1	1
	(ii)	**[Able to write a half equation correctly]**		
		Answer: $Fe \rightarrow Fe^{2+} + 2e$	1	1
(c)	(i)	**[Able to explain the rusting phenomenon of iron gate in coastal area]**		
		Sample answer P1. Presence of salt vapours in the air. P2. Increase the concentration of electrolyte in the air	1 1	2
	(ii)	**[Able to suggest one way to prevent the rusting of iron gate in coastal area]**		
		Sample answer Paint / grease / galvanizing the iron gate	1	1
(d)	(i)	**[Able to suggest metal X]**		
		Answer: Copper	1	1
	(ii)	**[Able to explain the differences in the observations]**		
		Sample answer		
		P1. In Set I, no reaction while in Set II, reaction occur // Copper/ Cu is formed. P2. Carbon is less reactive than aluminium/Al but more reactive than X	1 1	2
		Notes: *P1. Inference* *P2. Reason*		
	(iii)	**[Able to arrange elements in ascending order of reactivity correctly]**		
		Answer: X / Cu, Carbon, Aluminum	1	1
			Total	**10**

5		MARK SCHEME	SUB MARK	TOTAL MARK
(a)	(i)	**[Able to give definition of rate of reaction correctly]** Sample answer Change/Increase in volume of H_2 gas **per unit time** // decrease in mass of magnesium powder **per unit time**	1	1
(b)	(i)	**[Able to calculate the average rate of reaction with correct unit]** Answer: Experiment I = $\dfrac{0.4}{30}$ = **0.0133 g s^{-1}**	1	1
	(ii)	**[Able to calculate the average rate of reaction correctly with unit]** Answer: Experiment II = $\dfrac{0.4}{12}$ = **0.0333 g s^{-1}**	1	1
	(iii)	**[Able to sketch and labeled energy profile diagram correctly]** Answer: *[Correct shape of graph & Label]*	1	1

(c)	**[Able to compare and explain the rate of reaction based on collision theory between Set I and Set II]** <u>Sample answer</u> P1. Rate of reaction in Set II is **higher** than Set I. P2. Copper(II) sulphate solution provide an alternative route/ path with a lower activation energy. P3. More colliding particles able to achieve the lower activation energy. P4. The frequency of effective collisions between **hydrogen ions and magnesium atom** higher.	 1 1 1 1	 4	

(d)	**[Able to choose and explain which foods will last longer]**
	
	 Answer:
	 1. A
	 2. Lower temperature
	 3. The bacteria/microorganism is less reactive
	    // The bacteria produced less toxin
	    // Rate of food decay is lower
		
		 1
		 1
		 1
			
			 3	

		Total	**11**	

6		MARK SCHEME	SUB MARK	TOTAL MARK
(a)		**[Able to name the enzyme in Process 1]** Answer: Zymase	1	1
(b)		**[Able to draw the correct structural formula of compound X]** Answer:	1	1
(c)	(i)	**[Able to draw a labeled diagram in Pocess II correctly]** Answer: P1. Functional diagram P2. Label	1 1	2
	(ii)	**[Able to suggest a chemical test to identify compound Y]** <u>Sample answer</u> P1. Flow/channel compound Y / ethene into a test tube containing bromine water / Acidified potassium manganate(VII) solution P2. Brown [bromine water] decolourises / changes to colourless / purple [acidified potassium manganate(VII)] decolourises / change to colourless	1 1	2

(d)		**[Able to write a balance chemical equation]** Answer: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ P1. Correct formula of reactants and products P2. Balanced the chemical equation	1 1 1	2
(e)	(i)	**[Able to state the functional group of compound Z]** Answer: Carboxyl group / -COOH	1	1
	(ii)	**[Able to name the oxidizing reagent]** Answer: Acidified potassium manganate(VII) solution // Acidified potassium dichromate(VI) solution	1	1
(f)		**[Able to write molecular formula of compound produce correctly]** Answer: $CH_3COOC_2H_5$ // $C_4H_8O_2$	1	1
		Total		**11**

7		MARK SCHEME	SUB MARK	TOTAL MARKS
(a)	(i)	**[Able to state the polymer and write the chemical equation for the polymerisation of chloroethene]** Answer: P1: Polyvinyl chloride // polychloroethene // $\text{—}[\text{C}_2\text{H}_3\text{Cl}]_n$ // P2: $n\ \text{C}_2\text{H}_3\text{Cl} \rightarrow \text{—}[\text{C}_2\text{H}_3\text{Cl}]_n$ *[a:using structural formula]*	1 1	2
	(ii)	**[Able to explain how the usage of synthetic polymer substances can cause environmental pollution]** <u>Sample answer</u> P1: Synthetic polymer [PVC/ polystyrene/ nylon/ Kevlar/etc] P2: Not biodegradable P3: Blockage drainage system/ flash flood **OR** P1: Combustion/burning of polymer will released poisonous/toxic gas [CO / SO_2 / Cl_2 / HCl] P2: Gas dissolved in rainwater to produce acid rain P3: Increasing the acidity/ Lower pH of soil/lake/river/corrode metal/carbonate structure / fertility of soil decreases. **OR** P1: Combustion/burning of polymer, will released CO_2 gas P2: Greenhouse effect P3: Global warming.	1 1 1	3
(b)		**[Able to explain why alloy rim harder than iron rim]** <u>Sample answer</u> P1. Alloy rim is **harder** than iron rim P2. In iron rim, Fe atom are of the same size P3. The presence of <u>carbon atoms</u> of different size, P4. disrupts the orderly arrangement [lattice arrangement] of iron atoms. P5: Layers of atoms cannot slide easily /hardly/ difficult slide.	1 1 1 1 1	5

(c)		**[Able to state the quantitative information from the equation correctly and calculate the volume of oxygen gas evolved]**		
		P1: 2 mol of $Cu(NO_3)_2$ produced 2 mol of CuO , 4 mol of NO_2 and 1 mol of O_2	1	
		P2: Number of mol of CuO = $\dfrac{3.2}{(64+16)}$ = 0.04 mol	1	
		P3: 2 mol of CuO release 1 mol of O_2 0.04 mol of CuO release 0.02 mol of O_2	1	
		P4: Volume of O_2 = 0.02 (24) = 0.48 dm^3 *[r: no unit]*	1	4
(d)	(i)	**[Able to write a chemical equation correctly]** Answer: $2Mg + O_2 \rightarrow 2MgO$ P1. Correct formula of reactants and products P2. Balance equation	 1 1	 2
	(ii)	**[Able to explain the differences in the method used]** <u>Sample answer</u> P1. Magnesium is a reactive metal P2. Magnesium <u>easily</u> reacts/oxidised with oxygen to form magnesium oxide P3. Copper is less reactive than hydrogen (vice versa) P4. Hydrogen can reduce copper(II) oxide / CuO to copper	 1 1 1 1	 4
			Total	**20**

	8	MARKING SCHEME	MARK	TOTAL MARKS
(a)		**[Able to suggest one substance correctly and give two reasons for the suggestion]** Sample answer P1. Vinegar//ethanoic acid// acetic acid // Lemon juice (citric acid) // [weak acid] P2. Acid/ H^+ can <u>neutralize the alkali</u> P3: Less corrosive // does not produce too much heat // does not harm skin	1 1 1	3
(b)	(i)	**[Able to suggest acid X and acid Y correctly]** Answer: P1. Acid X : Sulphuric acid / H_2SO_4 P2: Acid Y: Nitric acid/HNO_3 // Hydrochloric acid /HCl	1 1	2
	(ii)	**[Able to write a balanced chemical equation correctly]** Answer: $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$ P1. Correct formulae of reactants and products P2. Balanced equation	1 1	2
(c)		**[Able to describe one chemical test to verify acid or alkali and write ionic equation for neutralization correctly]** Sample answer P1. Pour [2-5] cm³ of each solution in two different test tubes P2. Add [a piece] of metal/Mg / Al/ Zn [powder] // metal carbonate powder // $CaCO_3$ into each test tube. P3. If gas bubbles are released, an acid is present P4. If no change, alkali is present. **OR** P1. Pour [2-5] cm³ of each solution in two different test tubes P2. Add 2 cm³ of ammonium chloride solution [or any ammonium salt solution] into the test tube. P3. Heat the mixture. P4. The gas turns damp red litmus to blue and alkali is present.	1 1 1 1 1 1 1 1	4

(d)	(i)	**[Able to state the temperature of X and Y correctly]**		
		Answer:		
		P1. Initial temperature, *x*: 29.0 °C P2. Highest temperature, *y*: 43.0 °C	1 1	
		[Able to calculate the heat of neutralization correctly]		
		Answer:		
		P1. Number of mole HCl /NaOH = 50 X 2.0/1000 = 0.1 mol	1	
		P2. Heat released = (50 + 50) x 4.2 x [43.0 - $\frac{(29.0 + 28.0)}{2}$] = 6090 J	1	
		P3. 0.1 mol H_2O → 6090 J heat 1 mol H_2O → $\frac{6090 \times 1}{0.1}$ = 60, 900 J	1	
		P4. ΔH = - 60.9 kJ mol^{-1}	1	6
	(ii)	**[Able to predict and explain the change in heat of neutralization]**		
		<u>Sample answer</u>		
		P1. Lower. P2. Ethanoic acid is a weak acid / dissociate partially in water to form H$^+$ ion. P3. Some of the heat released is absorbed to ionise acid molecule <u>completely</u>.	1 1 1	3
			Total	**20**

9		MARK SCHEME	SUB MARK	TOTAL MARK
(a)	(i)	**[Able to explain the formation of compound]** Sample answer 1. Electron arrangement of sodium **atom** is 2.8.1 and chlorine **atom** is 2.8.7 2. To achieve [stable] octet electron arrangement. 3. Sodium atom will donate 1 electron to form sodium ion/Na^+ 4. Chlorine atom will receive 1 electron to form chloride ion/Cl^- 5. Strong electrostatic force of attraction between Na^+ and Cl^- forming ionic bond. *[any combination of Group 1 and Group 17 element]*	1 1 1 1 1	max 4
(b)	(i)	**[Able to suggest metal Y correctly]** Answer: Mg/Zn/Al *[r: Group 1 element / Ca]*	1	1
	(ii)	**[Able to determine and explain redox reaction]** Sample answer P1. Reaction I is a redox reaction. P2. Oxidation number of Y increase from 0 to +2 P3. Oxidation number of Cu decrease from +2 to 0 P4. Reaction II is not a redox reaction. P5. No change oxidation number for <u>all elements //</u> *[shows oxidation number for each element]*	1 1 1 1 1	5
(c)		**[Able to describe an experiment to investigate the reactivity of metals toward oxygen]** Sample answer **Procedure:** P1. One spatula of potassium manganate(VII) powder is placed in a boiling tube. P2. The boiling tube is clamped horizontally to a retort stand. P3. Glass wool is placed in the boiling tube. P4. One spatula of magnesium powder is placed on a piece of asbestos paper and put into the boiling tube. P5. The magnesium powder is **heated strongly** P6. Potassium manganate (VII) powder is heated. P7. Observation is recorded. P8. Steps 1 – 7 are repeated using iron and copper.	1 1 1 1 1 1 1 1	

[Lihat halaman sebelah

	Observation :			
		Metal	Observation	
		Magnesium	Burns vigorously with bright/ white flame	1
		Iron	Glows brightly	1
		Copper	Glows dimly	1
				max 10

		Total	**20**

10		**MARK SCHEME**	**SUB MARK**	**TOTAL MARK**
(a)		**[Able to identify type of rubber A and B and explain the differences in properties]**		
		P1. Rubber A : Vulcanised rubber	1	
		P2. Rubber B : Unvulcanised rubber	1	
		Elasticity		
		P3. There are **sulphur cross-linkages / links** between [polymer] molecules in vulcanised rubber	1	
		P4. When force is applied, sulphur cross-link / linkage will pull the **rubber molecules** back to its initial position.	1	
		Heat resistance		
		P5. The presence of sulphur in vulcanized rubber increases the size of rubber molecules/ molecular mass	1	
		P6. Difficult to melt //More heat needed.	1	6
(b)	(i)	**[Able to suggest compound P and Q]**		
		<u>Sample answer</u>		
		P1. Compound P : methanol/ethanol/propanol	1	
		P2. Compound Q : methanoic acid/ethanoic acid/propanoic acid	1	2
	(ii)	**[Able to state the general formula and functional group of compound P and Q]**		

			General Formula	Functional group		
	P1.	P	$C_nH_{2n+1}OH$; n = 1,2,3…	Hydroxyl/-OH	1	
	P2.	Q	$C_nH_{2n+1}COOH$; n= 0,1,2	Carboxyl/ -COOH	1	2

	(iii)	**[Able to describe an experiment to prepare compound Z]**
		
		P1. **Material:**
		     Pure methanol/absolute ethanol/propanol, pure methanoic
		     acid/glacial ethanoic acid/pure propanoic acid,
		     concentrated sulphuric acid
		
		Procedure:
		P2. Pour [3-6]cm^3 pure ethanol into a boiling tube
		P3. Add [3-6] cm^3 of pure ethanoic acid.
		P4. Add [a few drops] of concentrated sulphuric acid.
		P5. Heat/Warm the mixture **carefully/over a small flame** for a
		     few minutes.
		P6. Pour the product formed into a beaker containing water.
		P7. Observation: Fruity/Pleasant/Fragrance smell substance
		     produced // A layer formed on the surface of water
		
		OR
		
		Procedure:
		P2. Pour [20- 100]cm^3 pure ethanol into a round bottom flask
		P3. Add [20- 100]cm^3 of pure ethanoic acid.
		P4. Add [4 cm^3]of concentrated sulphuric acid.
		P5. Reflux the mixture.
		P6. Pour the product formed into a beaker containing water.
		P7. Observation: Fruity/Pleasant/Fragrance smell substance
		     produced // A layer formed on the surface of water
		
		$CH_3COOH + C_2H_5OH + \rightarrow CH_3COOC_2H_5 + H_2O$
		
		P8. Correct formula of reactants
		P9. Correct formula of products
		P10. Ethyl ethanoate*[depend to the students' answer]*
			1
			
			1
			1
			1
			1
			
			1
			1
			
			1
			1
			1
			1
			1
			1
			
			1
			1
			
			1	

			Total	**20**

TEST SPECIFICATION TABLE
SIJIL PENDIDIKAN MRSM
CHEMISTRY PAPER 2, 2020

Section	Question Number(Topic)	Construct of Elements Evaluated				
		CK 01 Knowledge	CS 01 Comprehension	CS 02 Application	CS 03 Analysis	CS 04 Synthesis
A	Q1 STRUCTURE OF ATOM PERIODIC TABLE	**4** 1a (i)[1m] 1a(ii)[1m] 1b(i)[1m] 1b(ii)[1m]	**5** 1a(iii)[2m] 1b(iii)[2m] 1b(iv)[1m]			
	Q2 ELECTROCHEMISTRY	**3** 2a[2m] 2b[1m]	**7** 2c(i)[1m] 2c(ii)[2m] 2c(iii)[2m] 2d(i)(ii)[2m]			
	Q3 SALT	**1** 3d[1m]	**5** 2a(i)(ii)[3m] 3e[2m]	**5** 3c(i)[2m] 3c(ii)[3m]		
	Q4 REDOX	**2** 4a[1m] 4b(i)[1m]	**7** 4b(ii)[1m] 4c[3m] 4d(i)[1m] 4d(ii)[2m]	**1** 4d(iii)[1m]		
	Q5 RATE OF REACTION	**1** 5a(i)[1m]	**5** 5a(ii)[1m] 5b(iii)[1m] 5c[3m]	**2** 5b(i)[1m] 5b(ii)[1m]	**2** 5d[2m]	
	Q6 CARBON COMPOUND		**1** 6a[1m]	**3** 6b[1m] 6c(i)[2m]	**4** 6c(ii)[2m] 6d[2m]	**2** 6e(i)[1m] 6e(ii)[1m]
B	Q7 MANUFACTURED SUBSTANCE & CHEMICAL FORMULA AND EQUATION		**10** 7a(i)[2m] 7a(ii)[3m] 7b[5m]	**6** 7c[4m] 7d(i)[2m]	**4** 7d(ii)[4m]	
	Q8		**8**	**4**	**8**	

	ACID BASES THERMOCHEMISTRY		8a[3m] 8c[5m]	8d(i)[4m]	8b(i)[2m] 8b(ii)[2m] 8d(ii)[4m]	

Section	Question Number(Topic)	Construct of Elements Evaluated				
		CK 01 Knowledge	**CS 01 Comprehension**	**CS 02 Application**	**CS 03 Analysis**	**CS 04 Synthesis**
C	Q9 CHEMICAL BOND REDOX			**4**	**6**	**10**
				9a[4m]	9b(i)[1m] 9b(ii)[5m]	9c[10m]
	Q10 CARBON COMPOUND				**10**	**10**
					10a[6m] 10b(i)[2m] 10b(ii)[2m]	10c[10m]

END OF MARKING SCHEME