JABATAN PELAJARAN NEGERI TERENGGANU
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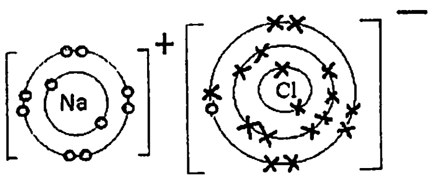
4541/2 CHEMISTRY
***Paper* 2**

Section A

<table>
<tr><td>1</td><td>(a) (i)</td><td>Melting point : 63 ^{o}C
Boiling point : 259 ^{o}C
[<i>values & unit</i>]</td><td>1</td></tr>
<tr><td></td><td>(ii)</td><td><table><tr><td>Region</td><td>Physical state</td></tr><tr><td>AB</td><td>solid</td></tr><tr><td>DE</td><td>liquid and gas</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>(iii)</td><td>The heat energy absorbed by the particles
is used to overcome the forces of attraction between particles</td><td>1
1</td></tr>
<tr><td></td><td>(b) (i)</td><td>7</td><td>1</td></tr>
<tr><td></td><td>(ii)</td><td>$^{33}_{16}Q$</td><td>1</td></tr>
<tr><td></td><td>(iii)</td><td>P and S</td><td>1</td></tr>
<tr><td></td><td>(iv)</td><td>Q and R
Have same number of protons but different number of neutrons //
Have same proton number but different nucleon number</td><td>1
1</td></tr>
<tr><td></td><td></td><td>TOTAL</td><td>9</td></tr>
</table>

2	(a) (i)	Ammonia	1
	(ii)	$(NH_4)_2SO_4$	1
	(b)	• Corrodes buildings • Corrodes metal structures • pH of the soil decreases • Lakes and rivers become acidic [*Any one*]	1
	(c) (i)	Urea, $(NH_4)_2CO$ $= \frac{2x\,14}{2(14+4)+12+16} \times 100$ // $=$ **43.8 %** Compound Y /ammonium sulphate, $(NH_4)_2SO_4$ $= \frac{2 \times 14}{2(14+4) + 32 + 4(16)} \times 100$ // $=$ **21.2 %**	1 1
	(ii)	Urea. Urea has a **higher percentage** of nitrogen by mass.	1 1
	(d) (i)	Produce **poisonous/toxic gases**	1
	(ii)	Recycle // Reuse // Pirolysis // Use biodegradable polymers	1
		TOTAL	9

3	(a) (i)	Proton number	1
	(a) (ii)	18	1
	(a) (iii)	Electric bulb // [*any suitable uses*]	1
	(b) (i)	Group 17, Period 3	1
	(b) (ii)	Size of sodium atom is bigger than chlorine atom Number of proton in sodium atom is more than chlorine atom Attraction force between nucleus and electron sodium atom is stronger	1 1 1
	(b) (iii)	Ionic	1
		Number of electrons occupied with electron & symbol *Charge of* Na^+ *and* Cl^- 	1 1
		TOTAL	**10**

4	(a) (i)	0.1 mol of HCl in 1 dm^3 of solution.	1
	(ii)	1. Mole of HCl $= \frac{3.65}{365}$ // 0.1 2. Concentration $= \frac{0.1}{0.5}$ // 0.2 mol dm^{-3}	1 1
	(b)	1. Concentration of hydrogen ion in Experiment I higher than Experiment II. 2. The higher the concentration of hydrogen ion, the lower the pH value.	1 1
	(c) (i)	pH value in **Experiment II** is **higher** than in Experiment III.	1
	(ii)	Concentration of hydrogen ion / H^+ in sulphuric acid is higher than hydrochloric acid.	1
	(d) (i)	Volumetrik flask	1
	(ii)	1. Mol = (1.0)(250) /1000 // 0.25 mol 2. Mass = 0.25 × 40 // 10 g	1 1
		TOTAL	**10**

5	(a) (i)	Lead(II) nitrate	1
	(a) (ii)	White	1
	(b)	To ensure all acid to be reacted completely	1
	(c) (i)	$PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O$ [*Formula of reactants and products correct*] [*Balanced*]	1 1
	(c) (ii)	Mole of $HNO_3 = \frac{50 \times 1}{1000}$ // 0.05 2 mol $HNO_3 \rightarrow$ 1 mol $Pb(NO_3)_2$ // 0.05 mol $HNO_3 \rightarrow$ 0.025 mol $Pb(NO_3)_2$ Mass of $Pb(NO_3)_2$ = 0.025 × 331 // 8.275 g	1 1 1
	(d)	(a) Add **dilute** sulphuric acid to solution followed by iron(II) sulphate solution Drop **concentrated** sulphuric acid slowly A brown ring is formed	1 1 1
		TOTAL	**11**

6	(a) (i)	A reaction where oxidation and reduction occurs at the same time	1
	(ii)	<table><tr><th>Set</th><th>1</th><th>2</th></tr><tr><td>Changes oxidation number of iron</td><td>+2 to +3</td><td>+2 to 0</td></tr><tr><td>Half equation</td><td>$Fe^{2+} \rightarrow Fe^{3+} + e$</td><td>$Fe^{2+} + 2e \rightarrow Fe$</td></tr><tr><td>Types of reaction</td><td>Oxidation</td><td>Reduction</td></tr></table>	1+1 1+1 1+1
	(b)(i)	1. X : Copper / silver / [*Other metal situated <u>lower</u> than iron in the Electrochemical Series*] 2. Y : Magnesium / zink / [*Other metal situated <u>higher</u> than iron in the Electrochemical Series*]	1 1
	(ii)	1 Iron atom lost electrons to form iron(II) ion / Fe^{2+} // Iron undergoes oxidation. 2 The iron(II) ion/ Fe^{2+} present	1 1
		TOTAL	**11**

Section B

7	(a)	Electrode copper X : **Type of electrode** Electrode carbon Y : **The position of ions** in the Electrochemical Series	1 1	2

(b)

Electrode	Carbon electrode Y (Cathode)	Copper electrode X (Anode)		
List of all ions present in electrolyte	Cu^{2+} , H^+ , SO_4^{2-} ,OH^-		1	
List of ions attracted to each electrodes.	Cu^{2+} , H^+	SO_4^{2-} ,OH^-	1+1	
Name of the ion selectively discharge and ion formed at electrode.	Copper (II) ion	Copper (II) ion	1+1	
The reason why the ion selectively discharge at cathode.	Cu^{2+} ion lower in the electrochemical series.	▨	1	
Half equation for the reaction at each electrodes.	$Cu^{2+} + 2e \rightarrow Cu$	$Cu \rightarrow Cu^{2+} + 2e$	2+2	10

	(c) (i)	Oxidation Release / donate electron	1 1	2
	(ii)	$4OH^- \rightarrow O_2 + 2H_2O + 4e$ [*Formula of reactant and products correct*] [*Balanced*]	1 1	2
	(d) (i)	Zinc More electropositive than copper	1 1	2
	(ii)	To allow the movement of ions Sulphuric acid [*any suitable substance*]	1 1	2
		TOTAL		**20**

8	(a)	(i)	heat is released when 1 mole of metal copper is displaced from copper sulphate solution by zinc metal.		1
		(ii)	$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$ [*Formula of reactants*] [*Formula of products*]	 1 1	2
		(iii)	1. Reactant : Zn & $CuSO_4$ 2. Product : Cu & $ZnSO_4$ 3. total energy of Zn & $CuSO_4$ is more/higher than total energy of Cu & $ZnSO_4$ 4. the reaction is exothermic / released energy 5. P kJ heat is released when 1 mol of copper is displaced	1 1 1 1 1	4
		(iv)	1. Heat released, Q $Q = 25 \times 4.2 \times 10$ // 1050 J mol^{-1} // 1.05 kJ mol^{-1} 2. Mol Cu ion = $\frac{0.2 \times 25}{1000}$ // 0.005 3. $\Delta H = -\frac{1.05}{0.005}$ kJ mol^{-1} // -210 kJ mol^{-1} 4. [*correct sign and unit*]	 1 1 1 1	4
		(v)	1. Heat is loss to the surrounding // 2. Themometer and beaker absorb some heat		1
	(b)	(i)	1. HCl is a strong acid // CH_3COOH is a weak acid 2. HCl ionise completely // CH_3COOH ionise partially 3. Some of heat released are absorbed by the CH_3COOH molecules to break the O-H bonds.	1 1 1	3
		(ii)	1. HCl is a monoprotic acid // H_2SO_4 is a diprotic acid // Number of H^+ ion in H_2SO_4 is **twice** 2. <u>Experiment I</u> : 1 mol of H^+ ion react with 1 mol of OH^- produced 1 mol of water ; heat released 57 kJ 3. <u>Experiment III</u> : 2 mol of H^+ ion react with 2 mol of OH^- produced 2 mol of water ; heat released **2** × 57 kJ	1 1 1	3
			TOTAL		**20**

Section C

9	(a) (i)	P : [***Name*** *of any metal situated above Cu in the ECS*] *Example* : Magnesium / Zinc / Aluminium [*reject* : Potassium / Sodium]	1	
		Q : [***Name*** *of any acid*] *Example* : Hydrochloric / Sulphuric / Nitric acid [*accept* : *weak acid*]	1	
		[*Chemical equation*] *Sample Answer* : $Mg + 2HCl \rightarrow MgCl_2 + H_2$		
		1. [*Correct formula of reactants and products*]	1	
		2. [*Balanced chemical equation*]	1	4
	(a) (ii)	Experiment I $= \frac{30}{10}$ $= 3.0\ \mathbf{cm^3\ s^{-1}}$	1	
		Experiment II $= \frac{30}{20}$ $= 1.5\ \mathbf{cm^3\ s^{-1}}$	1	2
		[*With correct* ***unit***]		
	(a) (iii)	1. **Rate** of reaction in Experiment **I** is **higher** than Experiment II.	1	
		2. The **concentration** of **acid** in Experiment **I** is **higher** than Experiment II // The **number of hydrogen ions** per unit volume in Experiment **I** is **higher** than in Experiment II.	1	
		3. **Frequency of collision** #between **hydrogen ions** and **atoms** of **P#** in Experiment **I** is **higher** than in Experiment II.	1	
		4. **Frequency of effective collision** between the particles in Experiment **I** is higher than in Experiment II.	1	4

(b)

*Factor : **Size of Reactant***

1. [***Name** of reactants used*] — 1

   Example :
   calcium carbonate**/marble chip and hydrochloric acid* //
   zinc** and sulphuric acid

Procedure :

2. A burette is filled with water and inverted over a basin of water and the burette is clamped vertically using retort stand. — 1
3. Initial burette reading is recorded. — 1
4. [1.0-2.0] g of **large pieces / granules** / pieces of metal** / metal carbonate is weigh and put into a conical flask. — 1
5. [20-50] cm^3 of [0.5-2.0] mol dm^{-3} acid* is measured and poured into the conical flask. The conical flask is closed immediately with stopper and delivery tube. — 1
6. Stopwatch is started and the conical flask is swirled throughout the experiment. — 1
7. The burette readings is record at 30 seconds intervals. — 1
8. Step 1 to 8 is repeated by using a **small pieces/powder** of metal / metal carbonate. — 1

9. *Results* : — 1

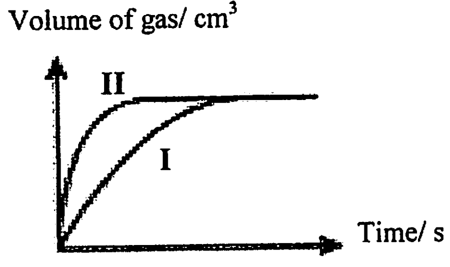
Exp. I : Using a large pieces of metal/metal carbonate

Time (s)	0	30	60	90	...
Burette reading (cm^3)					
Volume of gas (cm^3)					

Exp. II :Using a powder of metal /metal carbonate

Time (s)	0	30	60	90	...
Burette reading (cm^3)					
Volume of gas (cm^3)					

10. Sketch the graph of volume of gas against time for both experiment at same axes. — 1



[*Gradient of the graph using small pieces is **stepper/higher** than large pieces*]

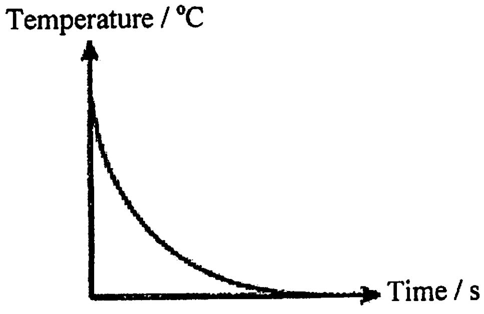
11. Rate of reaction using powder is ***higher*** than granules. — 1

Max **10**

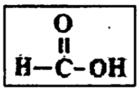
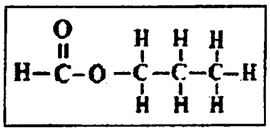
		*Factor : **Temperature***		
		1. [***Name** of reactants used*] *Example* : Sodium thiosulphate <u>and</u> hydrochloric /sulphuric acid*	1	
		Procedure :		
		2. [20 -100] cm^3 of sodium thiosulphate solution [0.1 – 1.0] mol dm^{-3} is poured into a conical flask.	1	
		3. The temperature of sodium thiosulphate is record.	1	
		4. The conical flask is placed on the top of piece of white paper with X-mark.	1	
		5. 5 cm^3 of [0.1 – 1.0] mol dm^{-3} hydrochloric acid* is measured and quickly poured it into the conical flask. The conical flask swirled throughout the experiment.	1	
		6. A stopwatch is started immediately.	1	
		7. The time required for the X-mark is disappear from sight is recorded.	1	
		8. Step 1 to 7 is repeated using sodium thiosulphate solution at 35 °C, 40 °C, 45 °C and 50 °C.	1	
		9. *Results* :	1	

Temperature (°C)	30	35	40	45	50	55	...
Time (s)							
1/time (s^{-1})							

		10. Plot the graph of : i) Temperature against time ***OR*** ii) Temperature against 1/time	1	



		11. *Conclusion* : The higher the temperature, the higher the rate of reaction.	1	*Max* **10**
		TOTAL		**20**

10	(a) (i)	Carbon dioxide/ CO_2 and water/ H_2O *Any one correct chemical equation* *Example* $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$ *Chemical formula of reactants* *balanced*	1 1 1	3
	(b)	Compound B & Compound D Same molecular formula / C_4H_8 Different structural formula	1 1 1	3
	(c)	Pour compound A/B into a test tube Add bromine water to the test tube Test tube contain compound A unchanged Test tube contain compound B brown colour turn colourless *or* Pour compound A/B into a test tube Add acidified Potassium manganate(VII) **solution** to the test tube Test tube contain compound A unchanged Test tube contain compound B purple colour turn colourless	1 1 1 1	4
	(d) (i)	*Any members of carboxylic acid and correct ester* *Example* [Methanoic acid] [Prophylmethanoate]  $H-\overset{\overset{O}{\parallel}}{C}-OH$  $H-\overset{\overset{O}{\parallel}}{C}-O-\underset{\underset{H}{\mid}}{\overset{\overset{H}{\mid}}{C}}-\underset{\underset{H}{\mid}}{\overset{\overset{H}{\mid}}{C}}-\underset{\underset{H}{\mid}}{\overset{\overset{H}{\mid}}{C}}-H$	1 1 1 1	4
	(d) (ii)	Pour 2 cm^3 of [methanoic acid] into a boiling tube Add 2 cm^3 of propanol/compound E into the boiling tube **Slowly/carefully/drop** 1 cm^3 of concentrated sulphuric acid Heated (with a small flame) the mixture Pour the mixture in a beaker that contain water *Observation* : formed liquid that fruity smell /float on water surface	1 1 1 1 1 1	6
		TOTAL		**20**

END OF MARKING SCHEME