

Name of Setter: Low Beng HongType of Paper: Prelim 2020 Subject: ChemistryLevel: 4E PCPaper : 6092/01Duration: 60minDate of Exam: Aug 2020

1	2	3	4	5	6	7	8	9	10
A	C	C	A	C	B	C	B	A	B
11	12	13	14	15	16	17	18	19	20
A	D	B	B	D	D	B	B	C	B
21	22	23	24	25	26	27	28	29	30
B	D	B	C	A	B	B	D	A	B
31	32	33	34	35	36	37	38	39	40
B	B	C	A	D	B	D	D	A	D

Paper : 6092/02Duration: 1hr 45minDate of Exam: Aug 2020Section A (50 marks)

A1	a	A: sulfur B: lead C: silicon dioxide D: lead(II) chloride	1 1 1 1
			1
A2	a	38 – 40 min Reject 36 min	1
	b	The reaction is <u>reversible</u> [1] and whatever product formed is decomposed to its reactants at the <u>same time</u> [1]. Since both forward and backward reactions occur at the <u>same rate</u> [1], amount of ammonia is not increasing.	2
	c	The use of a catalyst <u>speeds up</u> the reaction. This <u>saves energy</u> and thus energy cost [1]. In addition, the catalyst can be <u>reused</u> and hence there is <u>no recurring cost</u> in purchasing more catalyst [1].	2
	d	$\text{NH}_3 + 2\text{O}_2 \rightarrow \text{HNO}_3 + \text{H}_2\text{O}$ Accept $4\text{NH}_3 + 8\text{O}_2 \rightarrow 4\text{HNO}_3 + 4\text{H}_2\text{O}$	1
A3	a	$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ [1] let x be the energy of C – H bond Energy required to break bonds: $4x + 2(495) = 4x + 990$ Energy released in making bonds: $2(799) + 4(463) = 3450$ $4x + 990 - 3450 = - 889$	3

		$x = 393 \text{ kJ/mol}$ [1]	
	bi	ΔH of charcoal = $-(394/12) = -32.8 \text{ kJ/g}$ ΔH of methane = $-(889/16) = -55.6 \text{ kJ/g}$ } [1] Hence, student 1 is correct to say that methane produces more heat per gram.	1
	bii	$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ } [1] Since both fuels produce the same number of moles of carbon dioxide [1], hence charcoal does not produce less carbon dioxide than methane.	2
	biii	As charcoal is obtained from trees that are burnt, if trees are planted to replace those burnt, <u>the removal of carbon dioxide during photosynthesis will reduce the net amount of carbon dioxide in the atmosphere</u> [1], making it a more <u>carbon neutral</u> fuel compared to methane [1].	2
A4	a	Na, Ce, Mg, Al	1
	bi	CeO ₂ Reject Ce ₂ O ₄	1
	bii	amphoteric	1
	biii	high melting and boiling point; insoluble in water poor conductor of electricity hard and brittle high density Any 2 correct answers Accept: white powder Reject coloured compound	2
	c	Yes. As cerium forms compounds of <u>variable oxidation states</u> , it is likely to behave like a <u>transition metal</u> and are good catalysts.	1
	d	As cerium forms ions of +4 or +3 oxidation states, there are <u>more 'sea of delocalised / valence electrons'</u> to act as charge carriers compared to sodium, which only has one delocalised valence electron per atom[1]. Hence cerium is a better electrical conductor.	1
	e	Both magnesium and aluminium have a giant metallic structure and the strength of the metallic bonds is stronger in aluminium [1] as there are <u>more delocalised electrons</u> in the aluminium structure. Hence, the electrostatic <u>forces of attraction</u> between the positive nuclei and the valence electrons is <u>stronger</u> which require more energy to overcome[1]. Silicon has a <u>giant molecular structure</u> and the <u>covalent bonds are very strong and require a lot of energy to break</u> [1]. Hence, silicon has the highest melting point.	3
A5	a	sulfur dioxide is an <u>acidic gas and will dissolve in rain water</u> to form sulfurous acid, which is oxidised in the air to form sulfuric acid. This causes <u>acid rain</u> [1]. Acid rain <u>corrodes metallic structures and limestone buildings</u> , and cause lakes and ponds to become more acidic, <u>harming marine life</u> [1].	2
	bi	The amount of coal burned over the years increases, while the amount of sulfur dioxide emissions decreases over the same period.	1

	bii	sulfur dioxide is being <u>removed / desulfurised</u> [1] by <u>reacting with calcium carbonate/calcium oxide/ an alkaline substance</u> before the waste/flue gases are discharged to the environment, to meet regulatory requirement [1].	2
A6	a	Graph II: higher temperature / use of catalyst Graph III: 0.5 mol/dm ³ HCl// lower concentration of acid Both must be correct. Accepted: Graph II: 25 cm ³ of 2M HCl	1
	b	Zinc powder has a <u>greater surface area</u> compared to a piece of Zn metal, and hence there is more surface area for the acid particles to collide into [1]. This increases the <u>frequency of collisions per unit time</u> , leading to more <u>effective collisions</u> and a higher rate of reaction [1].	2
	c	<p>Volume of gas /dm³</p> <p style="text-align: right;">time /min</p> <p>Ethanoic acid is a <u>weak acid</u> and <u>dissociates only partially</u> in water, producing a low concentration of <u>hydrogen ions</u>, <u>causing a decrease in the rate of reaction</u>[1]. As it is also a <u>monobasic acid</u> like HCl and with the same concentration, it will react with zinc to produce the <u>same volume of gas</u> [1].</p>	3
	d	Add <u>50 cm³ of 0.5 mol/dm³</u> hydrochloric acid to a conical flask containing <u>3.00 g</u> of zinc. Stopper the conical flask immediately with a delivery tube connected to a <u>gas syringe</u> . Start the <u>stopwatch</u> at the <u>same time</u> . [1] Record the <u>volume of gas</u> produced at every 1 min <u>interval</u> . [1]	3
A7	a	Electrodes X: greenish-yellow gas observed [1] Electrodes Y: pink / reddish-brown / brown deposit formed [1]	2
	b	<u>Blue</u> colour of the electrolyte starts to fade and becomes <u>colourless</u> [1] As Cu ²⁺ ions <u>accept electrons more readily</u> compared to H ⁺ ions/ as Cu is below H in the reactivity series, Cu ²⁺ ions are <u>selectively discharged</u> . Thus the blue colour fades as <u>concentration of Cu²⁺ ions decrease</u> [1].	2
	c	The blue colour remains [1]. Copper anode is a <u>reactive</u> electrode. It will dissolve to form Cu ²⁺ ions in the electrolyte. Hence, there will be <u>no net loss in the concentration of Cu²⁺ ions</u> in the electrolyte [1].	2
	d	colourless solution turns brown.	1

B8	a	Distilled water <u>does not contain any minerals</u> . It requires 1.0 cm ³ of soap solution to lather and serves as a control. Sample A also requires <u>1.0 cm³ of soap solution</u> to lather after boiling. The <u>minerals have been destroyed by heat and thus contains only temporary hardness</u> [1]. Sample B requires 7.0 cm ³ of soap solution to lather after boiling, indicating that it <u>contains minerals which are not destroyed by heat</u> [1] and some minerals which have been <u>destroyed during the boiling</u> [1].	3
	b	Before boiling, total volume of permanent & temporary hardness = 13-1 = 12 cm ³ [1] After boiling, volume of temporary hardness = 13-7 = 6 cm ³ [1] Hence, volume of permanent hardness = 12 – 6 = 6 cm ³ [1] Therefore, the volumes are the same.	3
	c	Mg(HCO ₃) ₂ (aq) → MgCO ₃ (s) + H ₂ O(l) + CO ₂ (g) balanced equation [1] or correct state symbols [1] Ca(HCO ₃) ₂ (aq) → CaCO ₃ (s) + H ₂ O(l) + CO ₂ (g) When magnesium or calcium hydrogen carbonate decomposes, it forms an insoluble salt. The water is then <u>filtered</u> to remove the <u>insoluble</u> solids. [1]	3
	d	simple distillation	1
	e	The lime-scale forms a coating and <u>protective layer</u> inside the pipes. This prevents the steel pipes from being exposed to <u>water and oxygen</u> , <u>increasing its resistance to rusting</u> [1].	1
	f	The acid in the soil water will react with sodium carbonate. This <u>reduces the acidity of the soil water and increases its pH</u> , which may not be suitable for the plant [1].	1
B9	a	As <u>supply of gold</u> is so little and with such a <u>high demand</u> for gold, (possessing gold is a sign of wealth/ safe asset), it drives up the price of gold compared to other metals. Accept gold is a rare metal /exists in very small amount/ and therefore precious.	1
	b	No [1]. Al which is the <u>most abundant</u> , was the <u>most recent to be discovered</u> / Fe, which is second in terms of abundance, was discovered 1000 years after copper, silver, both metals which are ranked among the bottom in terms of abundance. In fact, gold which was the <u>least abundance</u> , was the <u>first to be discovered</u> [1].	3
	c	1807 / 1808	1
	d	The more <u>reactive</u> metals were discovered <u>later/ more recently</u> than the <u>less reactive</u> metals [1]. The reactive metals form stable compounds and therefore not so easily extracted without suitable technology while the less reactive metals exist in its elemental state and therefore easily discovered.	2
	e	The discovery of a suitable substance to <u>reduce the melting point</u> of the aluminium ore was only discovered later. Electrolysis could not decompose aluminium ore without this substance as Al melting point is too high.	1
Either B10	a	CaO(s) + H ₂ O(l) → Ca ²⁺ (aq) + 2OH ⁻ (aq) [1] balanced equation [1] state symbols	2

	b	Magnesium hydroxide is <u>less soluble</u> than calcium hydroxide and therefore is precipitated out. Accepted: Magnesium hydroxide is insoluble.	1												
	c	<u>Filter</u> the mixture to remove excess magnesium hydroxide as the residue [1]. <u>Evaporate</u> the filtrate to <u>dryness</u> to obtain the salt [1]. Accept crystallisation.	2												
	d	As Zn is <u>less reactive</u> [1] than Mg, Zn ions will be <u>preferentially discharged</u> [1] at the cathode rather than magnesium ion.	2												
	e	Anode: $2Cl^{-}(aq) \rightarrow Cl_2(g) + 2e^{-}$ [1] Cathode: $Mg^{2+}(aq) + 2e^{-} \rightarrow Mg(l)$ [1]	2												
	f	No. The oxidation state of chlorine decreases from <u>0 to -1</u> in HCl . Hence chlorine is <u>also reduced</u> .	1												
Or B10	a	mass of water = $5.67 - 4.05 = 1.62$ g [1] <table style="margin-left: auto; margin-right: auto;"> <tbody> <tr> <td></td> <td>$(COOH)_2$</td> <td>H_2O</td> </tr> <tr> <td>mass</td> <td>4.05</td> <td>1.62</td> </tr> <tr> <td>No of moles</td> <td>0.045</td> <td>0.09 [1]</td> </tr> <tr> <td>Mole ratio</td> <td>1</td> <td>2</td> </tr> </tbody> </table> Therefore, $x = 2$ [1]		$(COOH)_2$	H_2O	mass	4.05	1.62	No of moles	0.045	0.09 [1]	Mole ratio	1	2	3
	$(COOH)_2$	H_2O													
mass	4.05	1.62													
No of moles	0.045	0.09 [1]													
Mole ratio	1	2													
	b	1: Sample of potassium methanoate not pure / not all $HCOOK$ reacted [1] 2: Inadequate heating / not heated for long enough / not heated at a high enough temperature [1]	2												
	ci	<u>Filter</u> the mixture [1] <u>Add a few drops of calcium chloride solution</u> to the filtrate and see if a precipitate forms [1] Or <u>Allow the mixture to settle</u> [1] <u>pour out a little the clear part of mixture</u> , add a few drops of calcium chloride solution and see if a white ppt forms [1]	2												
	cii	Moles of calcium oxalate = $2.49/128 = 0.0195$ [1] \therefore Number of moles of potassium oxalate is also 0.0195 Mass of potassium oxalate is $0.0195 \times 166 = 3.24$ g [1] \therefore % of potassium oxalate in mixture = $[3.24/4.69] \times 100 = 69.1\%$ [1]	3												

